ART. II.—*On the Structures and Distribution of the Genera of the Arciferous Anura.*

By EDWARD D. COPE.

ARCIFERA.

Acromials and coracoids divergent, the former directed forward and connected with the latter by a longitudinal arched cartilage, which is free from and overlapped by the corresponding cartilaginous arch of the opposite side. Teeth on the upper jaw; tongue present. Tubæ Eustachii not overarched so as to be prolonged towards the median line.

In this tribe the extremes of the series are more diverse than in the others, and depend on the following features:

(1.) In that nearest the Aglossa, the vertebræ are like those of the latter and of the Salamanders, concave posteriorly and convex anteriorly: in the other extreme the reverse. These features are not as irreconcilable as might at first sight appear, as the intervertebral spheres do not become firmly attached to either centrum at maturity in some individuals of Borborocaetes peronii, Pelobates fuscus (Stannius) and Cultripes provincialis (Dugès). (2.) Those with opisthocœlian vertebræ agree with the bulk of the tribe in possessing dilated sacral diapophyses, whilst those at the other extreme exhibit them cylindrical. (3.) A few of the former possess small ribs, and (4) approach the normal condition of the so-called coccygeal vertebræ in possessing one pair of transverse processes; (5.) most of these, with the adjoining less extreme forms, have a vertical or cat-like pupil. (6.) Many

* The material from which the observations in this contribution, and that on the special characters of the Squamata (Proc. Acad. Phila. 1864, 224) were made, is that of the principal osteological collections of Europe, and alcoholic collections of Washington, Philadelphia, Berlin, London, Paris and Vienna. Vide Günther Zoolog. Record, 1864, where an inaccurate report of the latter article is given.

I may mention here an inadvertent omission in the memoir on Squamata, of a known distinctive feature between the Lacertilia and Ophidia; they should be contrasted thus:

Lacertilia.	*Ophidia.*
Continuity of parietal and sphenoid walls interrupted.	Continuity of parietal and sphenoid walls complete.
Palatines united by suture with maxillaries and vomer.	Palatines not in contact with maxillaries and vomer.
Rami of the mandible united by suture.	Rami of mandible united by ligament.

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of the same group exhibit a degraded or obliterated auditory apparatus; but this feature is not uniformly coincident with the preceding ones. (7.) The xiphisternum is formed of divergent limbs; in the bulk of the tribe it is an emarginate cartilaginous plate, and in the opposite extreme an osseous style, as in the Ranidæ.

Of these features, the first, third, fourth and sixth are agreements with, or approximations to the structures of the same elements of the Salamanders; the resemblances are borne out in the physiology of the same types.

In the observed examples of the above types, that is, of the Discoglossidæ, Pelodytidæ and Scaphiopodidæ, the eggs are deposited in small clusters, (Pelodytes), a short thick loop, (Pelobates), or in a series with a slender, tough, thread-like attachment, (Alytes). In the family following that of the Pelobates, that is, the New World tree-toads, the eggs are, in the only Old World species,—Hyla arborea,—deposited in globular masses, as among the Ranidæ, but much smaller; while in our Hyla pickeringii the masses include but from four to ten eggs. In the first mentioned forms, the male seizes the female in front of the arms, while in the remaining and major number of species, as well as in the observed Raniformia and Bufoniformia, she is seized round the axillæ.

In respect to the deposition of eggs, the peculiarity mentioned is an approximation to the mode observed by the Salamanders, which are deposited singly in the water (Triton, Notophthalmus)* on leaves, or on the land, connected by a tough thread (Desmognathus). Salamanders also seize the female in advance of the arms, but with the *hind* limbs; (Notophthalmus, Triton).

Additional peculiarities in the development of Alytes, Pelodytes,† Cultripes and Pelobates are, that they spawn at two seasons instead of one, and that their larvæ attain a larger size than those of other Anura before completing their metamorphosis. This latter feature is, however, repeated near the other end of the series—among those with cylindrical pelvic supports, in the genus Pseudis. What the significance of these peculiarities is, and what their coördination with structural characters, is not yet known.

The occurrence of a xiphisternal style similar to that of the Ranidæ, may be regarded as an indication of superiority, not only in consideration of this affinity, but as a greater degree of specialization and ossification of the part. It appears, however, not merely among the most Raniform Arcifera, but among some with procœlian vertebræ, which have the salamander-like mode of reproduction, and also among some of the opisthocœlian species.

* Notophthalmus viridescens lays its eggs singly on leaves, e. g., at the union of the capillary segments of Myriophyllum, or along their length, pressing them together on the egg as it is deposited. They adhere closely to its gelatinous surface, and serve to conceal it.

† Thomas, Ann. Sci. Nat. 1854, 290.

The seven natural families are characterized as follows:

I. Sacral diapophyses dilated; vertebræ opisthocœlian.

Ribs; xiphisternum of two divergent limbs; usually fronto-parietal fontanelle and coccygeal diapophyses; outer metatarsi separated by web, ... Discoglossidæ.

No ribs or coccygeal diapophyses; usually complete frontoparietals, and single coccygeal condyle: xiphisternum an osseous style; external metatarsi bound, ... Asterophrydidæ.

II. Sacral diapophyses dilated; vertebræ procœlian.

Terminal phalanges simple conic continuous; coccyx united by condyles, ... Pelodytidæ.

Terminal phalanges continuous conic; coccyx connate with sacrum, ... Scaphiopodidæ.

Terminal phalange with a swollen base and slender curved claw-like termination, articulated beneath the penultimate; coccyx united by condyles, ... Hylidæ.

III. Sacral diapophyses cylindric; vertebræ procœlian.

Mandible bearing teeth, ... Hemiphractidæ.

Mandible edentulous; external metacarpals usually bound together, rarely free, ... Cystignathidæ.

The only family features as above given, which seem to have a functional significance, are the structure of the terminal phalanges as an adaptation to arboreal life in the Hylidæ, and the increase of raptorial power by the addition of another set of teeth in the Hemiphractidæ. Yet for the first mentioned function how many other arrangements are employed among other genera?

We are at present acquainted with 265 species of this tribe, which represent 69 generic types: they represent the families in the following proportions and regions:

	Gen.	Sp.	Distribution.
Discoglossidæ, . .	5	6, . .	R. Palæarctica.
Asterophrydidæ, .	4	5, . .	R. Palæotropica, Australis.
Pelodytidæ, . .	2	2, . .	R. Palæotropica; Palæarctica.
Scaphiopodidæ, .	5	9, . .	R. Palæarctica, Nearctica.
Hylidæ, . . .	17	132, . .	(R. Palæotropica) R. Palæarctica, Nearctica, Neotropica, Australis.
Hemiphractidæ, .	1	2, . .	R. Neotropica.
Cystignathidæ, .	35	109, . .	R. Neotropica; Australis.

The generic forms are all peculiar to their zoological regions, except Hyla, found wherever its family occurs, and Borborocætes, common to Australia and the southern portion of South America.

The number of species so far known to inhabit these regions is as follows:

Regio Australis,	39,	R. Palæarctica,	9,
R. Neotropica,	176,	R. Æthiopica,	0,
R. Nearctica,	25,	R. Palæotropica,	7,
	240,		16.
In two regions,	1,	In two regions,	2.

The small proportion of species occurring in the old world, exclusive of Australia, is evident, though they represent five families, while those of the new world represent but four.

The slight attachment of the integuments to the muscles is a well known feature of the Batrachia Anura. The manner of this attachment presents many varieties in the different groups. The typical arrangement is uniform among the Raniformia, but reappears frequently among the other groups; it is as follows: A transverse partition of connective tissue holds the integument along the acromials, and another along the coracoids; a longitudinal band on each side of the back (frequently marked externally by a glandular fold) and one below it on each side of the abdomen. A band or line along the hinder inferior face of the thighs extending nearly to the popliteal region, and a delicate one along the upper hinder face of the same, from the groove between the superior and posterior muscles.

Among Bufoniformia the attachments are similar to the last in the Dendrobatidæ, in Paludicola and in Brachycephalus. In Engystoma o v a l e the lateroventral line is broad, or composed of several series of fibres and laminæ, and in E. c a r o l i n e n s i s it is composed of two septa. In Pseudophryne the dorsolateral septum, as well as the last mentioned, is widened; Phryniscus is similar, except that the dorsolateral is narrow posteriorly, but rapidly widening, meets its mate on the nape, forming a broad transvere attachment. In Atelopus l a e v i s the integument between the dorso- and ventrolateral septa is attached, forming a broad lateral adherent band. In Rhinophrynus d o r s a l i s this lateral attachment is carried so far as to leave only narrow free dorsal and ventral regions, while it is further peculiar in wanting the coracoid septum, as in Discoglossus and Dactylethra. Epidalea, Bufo, Phrynoidis and Peltaphryne, in their numerous species, add to the Raniform structure the attachment of the whole dorsal integument. The following table exhibits the other attachments:

Belly broadly free, very narrow lateroventral attachment: B. haematiticus, leschenaultii.

Do., broad lateroventral attachment: B. americanus, lentiginosus, cognatus, chilensis, boreas, vulgaris, naricus, sp. Vera Paz, vallifrons.

Do., posterior fourth or fifth abdomen attached: gracilis, speciosus, pantherinus.

Lateroventral attachment very broad, leaving but narrow free abdominal space: B. coniferus, quercinus, intermedius, punctatus, alvarius, diptychus.

Ventral integument attached: B. coccifer, insidior, viridis, kelaartii (posterior half attached.)

A considerable variety is exhibited by the families of the Arcifera. In the genera of Discoglossidæ examined (Discoglossus and Bombinator) the attachments are as in Ranidæ, except the absence of the coracoid septum, as in Dactylethra. On the contrary, in the Scaphiopodidæ, the integument is more or less entirely adherent above and below. The greater number, as well as typical forms of Hylidæ, add to the Raniform arrangement a close areolar attachment of the abdominal skin, while it is characteristic of many species of Cystignathidæ to possess one or two transverse, simple posterior abdominal septa. For the many variations and exceptions, see under the respective families.

Of the Aglossa, Dactylethra lacks the coracoid, and inferior femoral attachments; there is a double or treble but not wide lateral adhesion low down, which may be a combined dorsolateral and dorsoventral, or broad dorsoventral only. In Pipa all the attachments are wanting, except two closely approximated lateral lines, and a superior posterior and anterior inferior femoral.

The species of Arcifera, so far as known, exhibit some peculiar structures during the breeding season; either an extension of the natatory membrane, or the development of corneous plates or spurs, as aids to prehension. There is more variety and efficiency displayed in this point than among the Bufoniformia, but is in especial contrast to the apparent absence of all but the weakest modifications among the Raniformia. It is perhaps in compensation for the structure of the sternum, whose lateral halves being movable, offer a slighter basis of resistance for the flexor and extensor muscles of the fore limbs.

In the Discoglossidæ, Bombinator extends the natatory membrane in the male, but does not develope horny plates. In Discoglossus two file-like oval plates cover the superior surfaces of the short second digit, and the tubercle-like first, or thumb, which is here developed as in no other anurous batrachian. Dermal rugosities on the upper and under surfaces, including the gular region, are armed with corneous tips, as in Telmatobius. No peculiarity has been noticed in Alytes. The Asterophrydidæ are unknown.

In Pelodytes file-like plates are developed, one on the second and one on the third digit, one much larger on the forearm, one slightly smaller on the inside of the humerus, and a small one on each side of the breast.

Among Scaphiopodidæ the American species develope elongate laminæ on the

superior inner face of the inner (second) third and even fourth digits. No peculiarities are recorded as appearing in the European species.

Many Hylidæ,—Agalychnis, Trachycephalus—develope a corneous shield on the inner superior aspect of the inner metacarpal, which is prolonged on the digit.

While no appendages of the season have been observed in some Cystignathidæ, in several genera two acute spurs appear on the superior aspect of the thumb, and rarely spur-like tubercles on the breast; the body is sometimes shielded with hardened points on the rugosities, or the lip surrounded by an arched series of corneous rugæ. In one species the arms themselves increase remarkably in thickness and bulk, especially the brachium.

With regard to the differences in the arrangement and structure of the internal organs, a great deal remains to be observed. Henle (Anatomie des Kehlkopfes) points out some inconsiderable differences in the form of the cartilages of the larynx. The size and number of the pulmonary cells vary considerably. Among Hylidæ, especially those species with a loud voice, they are fewer and larger than in Discoglossidæ and Scaphiopodidæ. The forms of the sinus, auricles, ventricle and bulbus arteriosus, the three aorta bows, of which the median form the aorta roots, etc., appear quite identical externally in the Discoglossus, Scaphiopus, and Phyllomedusa. Internally the two former present the known characters of the Anura, *i. e.*, the union of the distinct ducts of the 1st (pulmonary) and 2d (aortic) aorta bows throughout much of their length, the separate union of the two former and continuance on the left side of a high free septum of the bulbus, till they are finally turned over the right division toward the right, and have a common issue from the ventricle. A conic pocket valve is at the origin of the bifurcation of the ductus communis of the second and third aorta bows, but none in any part of the course of the pulmonary.

The form of the liver does not differ from the usual type in any of the various species examined. In the alimentary canal there appears to be little variety in important points. The stomach has generally a more longitudinal position than among Bufoniformia, except among Scaphiopodidæ and in Ceratophrys, where it is equally transverse. No intestinal valves were observed in Pelobates, Hyla, Phyllomedusa, Ceratophrys, but a strong pyloric muscular constriction in Pleurodema, and one at the extremity of the small intestine in Cystignathus p a c h y p u s.

The testes are single in examples of all the types examined, and not strictly symmetrical; they are variously situated with reference to the kidneys. Thus in Ranoidea a u r e a, and Trachycephalus l i c h e n a t u s they are elongate and at the middle of the length of the kidneys, while in Hyla b o a n s and Scytopis v e n u l o s u s they are oval and one or both at the anterior extremity of the latter. In Phyllomedusa s c l e r o d e r m a they are more than half the length of the broad

kidneys, the right originating at the anterior extremity of the latter, the left but little behind it; both have their posterior apices in close contact, at the posterior fourth of the length of the kidneys, which are in close connection for their posterior third. In Discoglossus, the testes are oviform, well separated, and anterior, and during the breeding season attain a remarkably large size. During the same in Cystignathus pachypus, they are not materially enlarged, are elongate, and only in contact with kidneys for a small posterior part of their length.

The ovaries and oviducts do not essentially vary among the Anura; when the latter are fully occupied by eggs in an advanced stage they are folded, but differently in the same species. The oviducts are remarkably slender in Hyla nasuta (*Litoria* Günther), and in Scytopis venulosus. The fontanelle is on each side behind the partial diaphragm, at the superior anterior outer angles of the liver; in several young female specimens of Ranoidea aurea of the size of Rana silvatica, in which the frontoparietal fontanelle is not closed, the oviducts do not extend further anterior than the ovaries; in adults, with the cranium complete, they have the usual extent. In Gnathophysa ocellata* and gigas the "uterine" sacs at the exit of the oviducts are of great size and at certain seasons distended with an albuminous gelatine, when they present several convolutions. In spirits they occasion the presence of a large convoluted coagulated mass. In one specimen on one side this lay for the greater part of its length outside the abdominal muscles and above the lateroventral septum.

The tribe Arcifera was first defined and its extent and distribution indicated by the author in the Natural History Review, 1865, though explained a year previously at a meeting of the Zoological Society of London. The sternal feature characterizing it has been noticed by Steetzen, Cuvier and others in isolated cases, but its general significance not perceived: Dugès (Recherches, 64) attributes it to the tree-toads, the toads, and the Bombinator, Alytes and Pelobates. In Stannius'† Zootomie der Amphibien (73), it is assigned to the Aglossa and Bufo, as distinguished from Rana and Cystignathus. The characters of the last genus must have been taken from the Old World Cassina (formerly called Cystignathus), as the structure in Cystignathus and its allies is that of the true Arcifera.

These arches extend behind the so-called acromials to the extremity of the scapula; they have the same form and structure as during the earlier portion of the larval life of the Raniformia. In the latter, in maturing, they unite, and contract to a slender median rod, which gives with the superior transverse portions, a T-shaped element. Dugès has regarded this cartilage and its halves as equivalent to the fur-

* Rana ocellata L., *R. pentadactyla* of Laur., not *Cystignathus ocellatus* of later writers.

† A work which should be in the hands of all students of comparative anatomy.

cular clavicle of birds, Monotremata, and Lacertilia, (where it is often called mesosternum,) which view possesses much in its favor; but the presence of the arched cartilages connecting coracoids and acromials, *in addition* to the presence of the furcular and true clavicles in Lacertilia, opens the position to objection, and renders it quite possible that neither kind of clavicle exists among the Anura.* The question is therefore open to further investigation.

That the type of Arcifera is inferior to that of Raniformia, the structure of the sternum renders clear; it is also proven by the most usual undeveloped condition of the cranium in the former, its completeness in the latter, and the usual imperfection of what exists of the sternum, *i. e.*, the manubrium and xiphisternum, in the former, contrasted with its developement in the latter.

The Bufoniformia extend still lower, adding to the inferior sternum, the larval character of want of teeth; in many of the types, however, the sternum approaches, but never equals, the form of the Ranidæ, and offers a mark of superiority equivalent to the presence of teeth in the Arcifera.

C. Bruch, in an article on the Anura,† contends that the Bufones are the most elevated of this order, on account of their greater intelligence of movement, persistency of object, and adaptability. But this cannot weigh against developmental considerations, and is moreover a common order of things. The superior Quadrumana have every appearance of inferior intelligence to the dog or elephant; the Corvidæ are much more intelligent than the superior Turdidæ, and Woodward complains that the Maiid crabs are psychically much inferior to the Cancrid family, which are structurally below them. Perhaps this "intelligence" is only *impressibility* and *educability*, features which distinguish the young from the adult man as well, and are not consistent with that stamp of peculiarity fixed upon types by the greater length of their developmental scale.

DISCOGLOSSIDÆ.

Vertebræ opisthocœlian.‡ Diapophyses of sacrum dilated. First coccygeal vertebra united as usual with the second or style, but furnished with posteriorly divergent diapophyses, and attached to the sacral by two cotyloid cavities (with one exception). Short ribs articulated to the anterior diapophyses.§ Ossa fronto-parietalia enclosing a fontanelle (in existing genera). External metatarsi more or less separated by a web. Terminal phalanges continuous, simple. Xiphisternum of two slender postero-

* Vid. Natural Hist. Rev., l. c., where I have taken this view.

† Which contains much of interest, and advanced views on the systematic position of the European Arcifera. See Wurtzbürger Wissenschaftliche Zeitschrift, 1862, 222.

‡ Observed by Dugès and Gervais in *Alytes*.

§ Noticed by Dugès in *Alytes* and *Bombinator*, and Duméril in *Discoglossus*.

exteriorly diverging fibro-cartilaginous or cartilaginous styles. Tongue round, entire, and little or not at all free behind. Males without vocal vesicle.

If we commence the series of the Arcifera with the great family of the Cystignathidæ, we will end it with the families Asterophrydidæ and Discoglossidæ, which are perhaps equally connected with that which precedes them—the Scaphiopodidæ. The former leads to Dactylethra through Palæobatrachus; the latter, as far as our present knowledge indicates, finds its completest development in the extinct genus Latonia, established by Von Meyer on the L. seyfriedi from the miocene of Oeningen. A species also occurs in the freshwater deposits of Sansan, L. rugosa, whose salamander-like vertebræ have been noticed by Gervais.* These animals were nearly related to Discoglossus, and had, like it, short posteriorly-directed processes on the ribs, as in the genus Salamandra; they were, however, much larger, had the fronto-parietal bones completely ossified, and the whole of the cranium roughened externally by a dermo-ossification. On this account the genus has been compared with Ceratophrys, which belongs to the family of Cystignathidæ. This dermo-ossification occurs in various families, especially in the New World.

In the remaining and recent genera, the structure of the sternum is worthy of note. In old individuals of Discoglossus, it is sometimes fibro-cartilaginous, as in Pipa. The xiphisternum, proximally homologous with the xiphisternum of the Lacertilia, consists distally of the united hæmapophysial cartilages of the anterior ribs. In the genera in question,† this part is divided nearly up to the point of attachment to that preceding, each moiety being directed outwards and backwards, and tapering into a lateral linea semilunaris. Between these and the pubes there are in Discoglossus the usual three pairs of lineæ semilunares, connected on the median line by a strong linea alba.

In Discoglossus the prefrontalia are strongly developed, being in contact for most of their length, sometimes touching the fronto-parietalia. In Alytes they are also in contact throughout, but are transverse and do not reach the fronto-parietals; the fontanelle is larger, and the ribs without processes: the whole animal is weaker. In this genus, as well as the preceding, the pupil is a vertical slit; elsewhere found in Hylorhina, Platyplectrum, Limnomedusa, Pelodytidæ and the Scaphiopodidæ. A species, A. troschelii,‡ has left its remains in the miocene Braunkohle along with Palæobatrachus. Bombinator is similar to Alytes in its osseous structure, except that the prefrontalia are in contact anteriorly only, and that the sacrum presents but one condyle for the articulation of the coccyx, as is typical of the Asterophrydidæ and Aglossa. Along with Alytes and Dactylethra it has true ossa

* Palæontologie Française, p 494.

† Dugès has given a figure of it in *Bombinator*, pl. 3, fig. 24.

‡ *Rana troschelii* (Von Meyer, Palæontographica, iii. p. 138) is undoubtedly an *Alytes*.

nasalia, which bound the external nares exteriorly, thus explaining their anomalous position in Breviceps, where they are inferior. In this genus there is no cavum tympani or auricular ossicles, and the tubæ Eustachii are rudimentary or wanting. This character is said by Tschudi and Bruch not to be exceptionless in adults, and that the tubæ and tympanum are always present in the young of both this genus and Pelobates. All European.

Cephalic integument involved in cranial ossification, which completes the o. o. fronto-parietalia. Two coccygeal cotyli and diapophyses; ribs with posterior process, ... LATONIA.

Cephalic integument involved in cranial ossification; an open fronto-parietal fontanelle; no coccygeal diapophyses, two condyles. Temporal fossa roofed over, ... ZAPHRISSA.

Cephalic integument free; a small fronto-parietal fontanelle, (sometimes *apparently* closed by the ethmoid.) Prefrontalia largely in contact. Two coccygeal cotyli; ribs with posterior process. Pupil round. Cavum tympani present. No parotoid glands, ... DISCOGLOSSUS.

Cephalic integument free; a fronto-parietal fontanelle. Prefrontalia in contact throughout. Two coccygeal cotyli. No rudimental digit. Tympanum and cavum tympani distinct. Pupil erect. Parotoid glands present, ... ALYTES.

Cephalic integument free from cranium; a fronto-parietal fontanelle; prefrontalia in contact anteriorly. One coccygeal cotylus. No inner digit developed. No tympanum or cavum tympani; Eustachian tubes rudimental or wanting. Parotoid glands none, . . . BOMBINATOR.

LATONIA.

Von Meyer, Säugethiere Vögel u. Reptilien von Oeningen, p. 18.

L. seyfriedi von Meyer, l. c. Tab.

Habitat. Oeningen, Baden.

L. rugosa Cope, Nat. Hist. Review, 1865, 105. *Rana rugosa* Lartet (Notice sur la Colline de Sansan, p. 41); Gervais Palæontologie Française, p. 494. Tab. *? Rana gigantea* Lartet, l. c.

Habitat. Sansan, Southern France.

On account of the great brevity of Lartet's descriptions, it is not possible to deduce any characters by which to distinguish this species from the last. In both the temporal fossa is overarched, as in Cultripes, but in neither is the sacral diapophysis as much dilated as in this genus and Pelobates. The L. rugosa may, however, differ

in many points, since of the remains we possess, the humerus offers some distinctive marks. The latter exhibits two opposite proximal alæ, and one internal distally; all very strong. These are not represented in Von Meyer's figures of the largest of the seyfriedi. In the rugosa the front is a little swollen; there is no median superior process on the coccyx.

The remains of a vertebral column with sacral diapophyses much more dilated than either of the preceding, probably pertains to one of the species described by Lartet as Rana sansaniensis or R. laevis. Whether this be another Latonia, or an animal allied to Pelobates, is not easily determined. In the Natural History Review for 1865, No. I, I stated that a large species of Pelobates occurs in the miocene Braunkohle of Rott, near Bonn, Rhine-Prussia. A further study of a single specimen has convinced me that the species must be referred to the neighborhood of the genus Latonia; the sacrum is more dilated than in the known species, and resembles that of Pelobates. This is

ZAPHRISSA m.

Z. eurypelis sp. nov.

The general form is well displayed by an inferior view of the whole skeleton. The extremities, especially the feet, and the pelvis of this species, are elongate. The terminal phalanges were short conic; the exterior or long metatarsals are closely juxtaposed, the outer the shorter of the two. The tarsal bones are preserved; the cuneiform was small and little prominent. The length of the astragalus and calcanium is little less than half the tibia: the latter is relatively slender, flattened and grooved at both ends. The ilia are slightly incurved, slightly compressed distally, and as long as the femora. The impression of the coccyx does not display a strong dorsal keel; its position corresponds with the axis of the sacrum, although other portions of the skeleton have been much disarranged; the traces of a small sacral condyle indicate the union with the sacrum by double condyle, as usual in this family.

The sacral diapophyses are remarkably expanded, almost as in Pipa or Cultripes: they articulate with the proximal three-fifths of the ilia. The remaining vertebræ have been much disarranged; they were probably eight in number. The atlas is distinct, without processes, necessarily much expanded anteriorly for articulation with the large and separated occipital condyles, and about as long as wide. The diapophyses of the second, third and fourth vertebræ are the only ones preserved; those of the second are longest, and articulate without constriction, with a cylindrical costal appendage. The terminal portion of this is lost, but it has not probably exhibited a posterior process, nor been much dilated. The third pair of diapophyses are the

shortest, and are rather depressed at their articulation with the ribs, which are the longest, nearly straight and slightly widened distally. The fourth diapophyses is equal to the third, but heavier and directed anteriorly; its rib is transverse, heavier, but shorter than the last.

The cranium is broad, with its whole surface roughened by the development of numerous minute, inosculating ridges, forming a coarser pattern than in any recent species, and leaving a nodular relief. The temporal fossa was overarched by a thick lamina, as portions remaining indicate, and the ossification formed a supra-orbital ala beyond the brain case, as in Latonia seyfriedi and Ceratophrys. The impression of the fronto-parietal bones is interrupted medially by an elongate oval elevation of the matrix. This is bounded before by the concave border of a smooth bone, whose impression is of the usual form of the superior ethmoid plate. I cannot conceive this to be anything other than an indication of a frontoparietal fontanelle, though I know of no form combining this feature with dermoossification, or the overarched temporal fossæ. The impressions of the prefrontals are very distinct; the greater part of the substance of one remains. Their form bears some resemblance to that in Pelobates; their common anterior suture does not measure one-half their longitudinal extent. The superior ethmoid plate presents a *narrow* posterior concavity for the fontanelle; it has left no rugose impression in the matrix. The frontoparietals exhibit a broad lateral wing, as occurs in Latonia and Pelobates, which passes into the postorbito-temporal arch. The latter is broad, and continues into a strong posterior dilatation of the "temporo-mastoid," which includes with the end of the quadratum a deep sinus.

The anterior limb is elongate. Scapula and supra-scapula preserved, undivided: humerus broad proximally, and with a right anterior outline, which is probably a bicipital ridge; no apparent posterior ridge. Distally more transversely compressed than in Pelobates fuscus, at the base of the prominent condyle. Forearm with two distal longitudinal grooves. The impressions of the carpals are very distinct; that of the lunare larger than that of the cuneiforme; and that of the unciforme representing a bone larger than any other, but not prominent. The impressions visible are three proximal, two distal. The fingers are elongate.

The sternum and one arm were pressed across the cranium, and are mutilated; hence the important point as to whether the xiphisternum is bifurcate or styloid remains for a more fortunate observer. Measurements are as follows:

	In.	Lines.
Length from end muzzle to posterior margin ethmoid,		5
" " level of occipital condyle,		12·5
Interorbital breadth (behind middle),		5·3
Breadth of temporal arch,		4·3

	In.	Lines.
Thickness of temporal arch,		·8
Breadth between extremities of quadrata, as crushed,	1	7·5
Transverse extent of third vertebra with appendage,		8
" " fourth " "		8
" " sacral " "		5·8
Length of sacral diapophysis,		8
" of ilium,	1	3·6
" of coccyx,		9
" of femur,	1	2
" of tibia,	1	2
" of tarsus,		7
" of fifth metatarsus (exterior),		4.5
" of fourth "		5·5
" of first "		2
" of third digit from tarsus,		11
" of humerus,		10
" of ulna and radius,		7·3
" of third metacarpus,		3·2

This species was the cotemporary of the Morelia papyracea, the Palæobatrachi Ranæ and Cyprinidae of the period and place of deposit of the Braunkohle of Rhine-Prussia.

ASTEROPHRYDIDÆ.

Vertebræ opisthocœlian. Diapophysis of sacrum dilated, of first coccygeal vertebra wanting; the latter attached by but one cotyloid cavity (except in one genus). Ribs none. External metatarsi not separated for a web; terminal phalanges continuous, simple. O. fronto-parietalia not strongly ossified medially, but without fontanelle. Superior plate of the ethmoid well developed anteriorly. Ear perfectly developed. Xiphisternum a slender osseous style (first two genera not examined).

Genera: Cryptotis, *Gthr.;* Asterophrys, *Tsch.;* Megalophrys, *Kuhl;* Xenophrys, *Gthr.*

The Palæobatrachidæ differ from this family in the conversion of their seventh, eighth, and ninth vertebral centra and diapophyses into a sacrum, instead of the ninth only; and in the osseous covering of the cavum tympani and tuba Eustachii.

Cryptotis, the only Australian genus of the family, possesses two sacral condyles for the articulation of the coccyx; it has a long tooth-like process on the os dentale, similar to that seen in Rana macrodon, and R. kuhlii.

The other genera belong to the Malayan Islands, except Xenophrys, which has only been found in the mountains of India. There are no arboreal or aquatic forms embraced in this family. The whole number of species known is five.

a. Toes free.

Two coccygeal cotyli. O. dentale with a dentiform process. Vomerine teeth; no parotoids; palpebra simple, ... CRYPTOTIS.

One coccygeal cotylus. No dentiform process. Head large angular; upper palpebral border with cutaneous appendages. Vomerine teeth. Tongue entirely adherent. Tympanum hidden, perfect, ASTEROPHRYS.

No dentary apophysis. Head ordinary, no dermal appendages. No vomerine teeth. Tongue broad, but little free. Tympanum distinct, ... XENOPHRYS.

aa. Toes partially webbed.

Very much depressed; cleft of mouth large. Vomerine teeth little developed. A superciliary dermal appendage. Tongue broad, free behind: (tympanum concealed), ... MEGALOPHRYS.

PELODYTIDÆ.

Vertebræ procœlian; no ribs or diapophyses of coccyx. Sacrum united with the coccyx by condyle, its diapophyses thin and largely dilated. Xiphisternum an osseous style, with terminal disc. External metatarsi bound together.

The species of this family are of weak organization; the fronto-parietal bones are undeveloped in one of the two genera embraced by it, and they are very weak in the other. Their affinities are altogether between the Asterophrydidæ and Scaphiopodidæ. Their vertebræ only distinguish them from the former, and their distinct bicondyloid coccyx from the latter. In both genera the auditory apparatus is developed, and the cephalic integument is free; in neither is there a metatarsal shovel.

Fronto-parietal bones complete; no vomerine teeth; one sacral condyle for coccyx: tongue partially free, ... LEPTOBRACHIUM.

Fronto-parietal bones embracing a large fontanelle; vomerine teeth; two sacral condyles for the coccyx; a weak parotoid gland; pupil elliptic erect; tongue partially free. Atlas and axis confluent, . PELODYTES.

SCAPHIOPODIDÆ.

Vertebræ procœlian; no costal elements or coccygeal diapophyses; diapophyses of ninth vertebra much dilated, thin and triangular; coccygeal style without condyloid

articulation, its axial portion restricting that of the sacrum and connate with it: external metatarsi bound; distal phalange continuous, simple. Manubrium cartilaginous. Tongue rounded, nearly entire.

The small number of species embraced in this family are of stout toad-like habit, and furnished with a shovel-like development of the cuneiform bone and a coriaceous posterior digital palmation, to aid them in removing earth while making their subterranean abodes. Many of them very seldom come to the surface of the earth, and then only in darkness; for this habit the vertical cat-like pupil is an adaptation, a peculiarity not exhibited by the toads, which are crepuscular.

Group I. Cavum tympani and tympanum wanting. Xiphisternum with an ossified proximal style. Cuneiform bone and sheath well developed. Pupil erect. Toes webbed.

Derm involved in cranial ossification. Temporal fossa with a strong roof. Vomerine teeth: no parotoid glands, ... CULTRIPES.

Derm involved in cranial ossification. No roof over the temporal fossa, or parotoid glands. Vomerine teeth, ... PELOBATES.

Derm distinct from cranium, which is undeveloped above, two lateral fronto-parietal bars enclosing a median fontanelle. Vomerine teeth. No parotoids, ... DIDOCUS.*

Group II. Cavum tympani and tympanum present. Xiphisternum entirely cartilaginous. Cuneiform bone and sheath well developed. Toes more or less webbed. Pupil elliptic erect.

Derm involved in the cephalic ossification, which is complete. Parotoid glands and vomerine teeth, ... SCAPHIOPUS.

Derm distinct from cranium, which is only ossified superiorly in two superciliary bars. Parotoid glands and vomerine teeth, . . . SPEA.†

The extreme of divergence of the series of this family is, then, that representing its type in a preëminent degree. This is seen in the genus Cultripes where the ossification of the superior cranial walls is especially thickened, obliterates the sagittal

* Type Rana calcarata Michahelles Isis von Oken, 1830, 160. In the lack of a good series of specimens of Cultripes provincialis, I should have hesitated to separate this species generically from the latter, remembering the very late period of completion of the cranium in Ranoidea aurea of Australia. But Dugès' "Rech. Ost. et Myol.," etc., p. 93, says that the parasphenoid and frontoparietal bones are simultaneously and early completed, and illustrates in a figure the confluence of the latter while quite young. Duméril, Erp. Générale, viii. 484, states, moreover, that the temporal roof is developed before the tail of the larva has disappeared. In our specimen, which is fully developed, though not of large size, the temporal muscles are only enclosed by the usual fascia. The species occurs in southern Spain. See my forthcoming memoir in the Smithsonian Contributions.

† Type Scaphiopus bombifrons Cope; embraces S. hammondii Baird, and S. multiplicatus Cope.

suture, and is extended in an arch over the temporal fossa. The anterior ossification of the coccyx is applied by its axial portion beneath the axis or centrum of the sacral vertebra, and becomes consolidated with it shortly after its commencement, furnishing a structure not rare among burrowing Anura. This character is maintained in the descending scale by Pelobates, Didocus, Scaphiopus and Spea, though none of these have the temporal fossa overarched. Cultripes, with Pelobates and Didocus, exhibit an ossified basal xiphisternal piece, while in all below it is cartilaginous, as in most Arcifera: the extreme position of the former is also maintained by the obliteration of many portions of the auditory apparatus. The succeeding forms Scaphiopus, Spea and Helioporus, resemble the first group in the toad-like form, and in the strong cuneiform shovel and webbed feet, but in the last the usual bicondyloid articulation of coccyx brings us within the limits of the Cystignathidæ, and with Spea, an incomplete cranium marks a descent. The more elongate Cystignathid form of Chiroleptes maintains the Scaphiopod foot, with a strong cranium, while in the same family the superficially similar Hyperolia exhibits no longer the cuneiform shovel, or any true mark of affinity.

The distribution of the species of the family is as follows:

	R. Austr.	R. Neotrop.	R. Nearctica.	R. Palæarct.	R. Aethiop.	R. Palæotropica.
Cultripes,	0	0	0	?1	0	0
Pelobates,	0	0	0	1	0	0
Didocus,	0	0	0	1	0	0
Scaphiopus,	0	0	3	0	0	0
Spea,	0	1	2	0	0	0
		1	5	3		

The inferior dermal attachments of seven species of this family are as follows:

Didocus calcaratus; belly more than half attached.

Pelobates fuscus; from half to two-thirds attached; same in larva, with long tail. Femur one line below.

Scaphiopus holbrookii; free only opposite sternum; thigh attached only below on basal half.

Scaphiopus couchii. Triangular free area to middle abdomen.

Spea hammondii, very wide lateral inferior attachments, which do not meet till femora.

Spea bombifrons. Belly with a free median band; femoral lines, below and above behind.

Spea multiplicata. A free dorsal line, very narrow in front, but wide as ilia behind; abdominal area with a broader free space.

HYLIDÆ.

Vertebræ procœlian. Sacral diapophyses dilated, the simple coccyx articulated to two condyles. External metacarpi bound together. Terminal phalanges articulated inferiorly on to the extremity of the penultimate, globular or swollen proximally, and giving rise, usually from a central emargination, to the curved, acute distal portion which is of a more compact tissue. O. frontoparietalia shortened anteriorly, usually embracing a fontanelle. Superior plate of ethmoid never covered by frontoparietals, usually produced anteriorly, between frontonasals. Ear perfectly developed. Abdominal integument areolate.

This family embraces the tree-toads of Australia and America. It presents comparatively little structural variety, not containing as undeveloped types as the Cystignathidæ, nor as high ones: it possesses neither earless genera, nor fossorial, nor really aquatic.

The adaptive modifications are: first, those which accompany a terrestrial habitat, *i. e.*, the diminution of the digital dilatations and palmation. These occur in regularly increasing degree, in a small number of the species of the typical genus Hyla, and are general in, and distinctive of, two other genera. Second, those which adapt the extremities to grasping a limb by opposition of digits, instead of adhering to a surface by expansion of them in one plane. This first appears in a species of Agalychnis, and is permanent in Pithecopus and Phyllomedusa. Third, those which restrict the light admitted to the retina, first, by the lateral contractility of the pupil; second, by the rendering opaque of the inferior palpebra. The first characterizes the three genera just mentioned, the last occurs in the first two, but is inconstant in the second, and appears in two species of the genus Hyla. Fourth, that which adapts the female during the breeding season to localities without water, or where perhaps the water contains enemies, by the inversion of the dorsal integument so as to form a sack, in which the eggs are carried. This occurs in, and is accepted as characteristic of two genera, of one species each, but as it occurs in but one sex its value is questionable.

Another feature, which may have a functional value, is the union of the abdominal integuments with the superficial fascia of the muscles by an areolar or fibrous network, continuous with that of the usual latero-ventral band. The skin of the inferior surfaces of these creatures, as in the Raniform tree frogs, has a thickening in numerous close areolæ, the nature and function of which is like that of the digital dilatations, and the derm of the tuber on the thumb of the male Rana, *i. e.*, to secrete an adhesive fluid as aid in maintaining the peculiar positions assumed. In proportion to the developement of these, is the extent of the abdominal attachment, and hence may be supposed to be adapted for relieving the other areolar connections from the

strain of the animal's weight when in an appressed or vertical position. Its uniformity in the burrowing genera of the Bufonidæ and Scaphiopodidæ, and especially on their dorsal surface, rather confirms this view.

This connection is, however, evidently not necessary to the use of the abdominal integument as an adhesive support, as this faculty is nowhere better seen than in Acris, where the derm is free. This creature will adhere for days to a vertical glass plate, not only by the abdomen and digits, but by the interdigital membranes, and will light securely from a long leap on such a surface. Daudin and Duméril have related the same adhesive faculty in Pelodytes punctatus, which is not known in regard to the dermal attachments, but has not the abdominal areolæ present in Acris. The extent of the attachment is least where the dilatations are smallest, as follows:

Abdomen entirely attached; 18 sp.

Phyllomedusa two sp. Pithecopus two sp. Agalychnis three sp. Trachycephalus two sp. Nototrema one sp. Scytopis two sp. Smilisca baudinii.

Hyla albomarginata, boans, agrestis, krefftii, phyllochroa.

Posterior half or third of abdomen attached; latero-ventral band wide.

Triprion petasatus.

Hyla fusca, arenicolor,* gratiosa, versicolor, femoralis; squirella, andersonii, cyanea.

Ranoidea aurea.

Chorophilus triseriatus.

Less than posterior third abdomen attached; the latero-ventrals wide.

Hyla arborea, regilla, lateralis, cadaverina† miotympanum; pickeringii.

Chorophilus nigritus.

Abdomen entirely free.

Hyla leseurei, curta, gracilipes. Acris gryllus.

Of distinguishing features, which refer to the conditions of the elements of the vertebrate skeleton, their degree of developement, etc., it may be said that they exhibit far fewer cases of questionable or intermediate existence than those of the previous class. They are, first, the developement of the o. o. frontoparietalia; second, of the prefrontalia; third, of the superficial cranial rugosities; fourth, of vomerine teeth; fifth, of a postfrontal arch; sixth, of the ethmoid arch.

Whole number of species,	131
Frontoparietals fully developed,	19
" with rugosities penetrating derm,	11
Prefrontals developed,	17

* H. affinis Baird, not Spix.

† H. nebulosa Hallow., not of Spix.

With vomerine teeth, ... 128
With postfrontal arch, ... 1
Ethmoid arch complete, ... 130

Of the above characters, the lack of vomerine teeth is inconstant in Pithecopus, being present in one, and wanting in another species.

There is a tendency to the Pseudis and Rana liberation of the outer metatarsus in Hyla americana, hypostricta and dimolops, and Ranoidea aurea.

Parotoid glands occur in somespecies of Hylidæ as an extensive stratum of crypts, but never exhibit the definition seen in Bufoniform and some Cystignathid genera. It even occurs in Scytopis venulosus irregularly, being sometimes present, and sometimes wanting, in the female at least.

The xiphisternum exhibits the form which exists in the greater number of Cystignathidæ, excepting in eight species, where it only lacks the posterior emargination.

The natural genera are as follows:

I. No frontoparietal fontanelle.

a. Cephalic derm occupied by the external rugosities of the cranial bones: prefrontals in contact.

A series of parasphenoid teeth or acute serrations; vomerine teeth.
No dorsal sac; labial margin much prolonged, . . . TRIPRION.
Vomerine teeth; no parasphenoids or dorsal pouch, . . . TRACHYCEPHALUS.
Vomerine teeth; a dorsal pouch; no parasphenoids, . . . OPISTHODELPHYS.

aa. Skin free from the surface of the cranium.

A dorsal dermal pouch in ♀; prefrontals partly united: vomerine teeth; dilatations small, ... NOTOTREMA.
No dorsal dermal pouch; prefrontals united; cranium with carinæ; vomerine teeth, ... OSTEOCEPHALUS.
No dorsal pouch; prefrontals united; no cranial carinæ; vomerine teeth, ... SCYTOPIS.
No dorsal pouch; prefrontals narrow, well separated; outer metatarsi bound; a ? coccygeal diapophysis; vomerine teeth, . . DRYOMELICTES.
No dorsal pouch; vomerine teeth; outer metatarsi slightly free; no coccygeal diapophysis, ... RANOIDEA.

II. Frontoparietal bones embracing an extensive fontanelle.

a. A dagger-shaped postorbital process of the frontoparietal bone.

Vomerine teeth; form stout, feet webbed, ... SMILISCA.*

aa. Frontoparietal simple.

* Species, S. baudinii (*Hyla baudinii* D. and B.); the name "*daulinia*" must probably be considered an erroneous orthography of the same.

b. Posterior digits free, two opposed to three; xiphisternum entire; pupil vertical.

A large prominent paratoid; inferior palpebra transparent; tongue extensively free laterally and behind, ... PHYLLOMEDUSA.

Parotoid very thin or wanting; tongue free; inferior palpebra netted or transparent; second toe shorter than inner, . . PITHECOPUS.*

bb. Posterior digits rarely opposable, pupil rarely vertical; xiphisternum deeply emarginate.

c. Pupil vertical; inner posterior digits more or less opposable.

Tongue elongate, extensively free laterally and behind; inferior palpebra latticed; toes more or less webbed, second longer than inner; sometimes thin parotoids, ... AGALYCHNIS.†

cc. Pupil horizontal; posterior digits webbed, not opposable.

Tongue short, attached or little free; palpebra usually transparent; vomerine teeth, ... HYLA.

Tongue short; palpebra transparent; no vomerine teeth, . . HYLELLA.

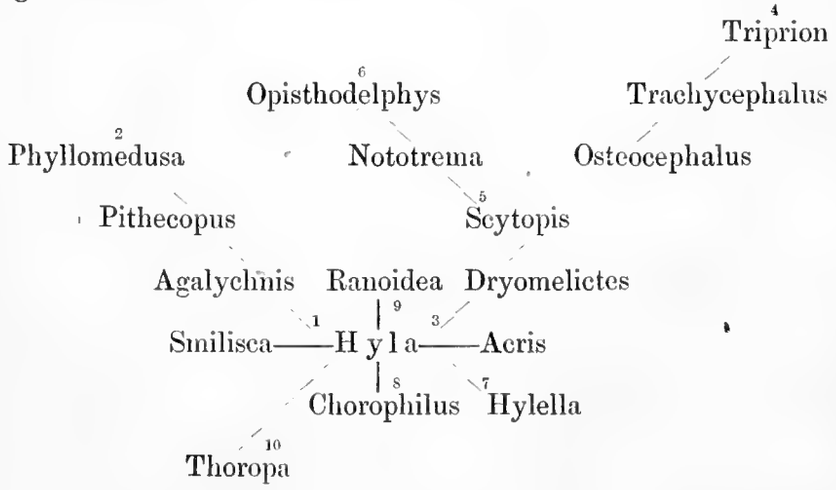
Tongue extensively free; dilatations minute, palmation extensive behind; vomerine teeth, ... ACRIS.

ccc. Pupil horizontal; posterior digits flat, free.

Superior ethmoid plate osseous; prefrontal bones separated, . CHOROPHILUS.

Superior ethmoid plate cartilaginous, the prefrontals developed, in contact medially, ... THOROPA.

The affinities of these genera are most readily exhibited by an arrangement like the following:



* Type P. azureus; second species P. hypochondrialis (*Hyla hypochondrialis* Daudin).

† Includes Phyllomedusa dacnicolor Cope.

In the series 1—2 to Phyllomedusa a final diminution of palmation accompanies continued size of the digital pallettes and increase in the length and breadth of the ethmoid, and diminution of the frontoparietals, which features, however, are as marked in Hyla palmata as in these succeeding types: they carry to its fullest developement the cranial peculiarities of the family, and add other features before mentioned; they inhabit the continental subregion of the Neotropical. The other main series (3—4) leads, first, to a fuller developement of the frontoparietals, then to an extension of the prefrontals, and finally to covering of the cranium with "dermoössification," on the one hand with the superaddition of a dorsal dermal sac, on the other without it. This extreme finds its greatest expansion in the West Indian subregion. A singular incompleteness of the cranial box seems to mark Thoropa, which has the strong nasal roofing of this second series.

Chorophilus exhibits an affinity to the Cystignathidæ, as does also Thoropa, which represents in inferiority Eusophus in the same family.

The following is the geographical distribution of the genera and species:

	R. Australis,	R. Neotropica,	R. Nearctica,	R. Palæarctica,	R. Aethiopica,	R. Palæotropica,
Triprion,		1				
Opisthodelphys,		1				
Trachycephalus,		9				
Osteocephalus,		2				
Nototrema,		1				
Scytopis,		3				
Ranoidea,	1					
Dryomelictes,		1				
Pithecopus,		2				
Phyllomedusa,		2				
Agalychnis,		4				
Smilisca,		1				
Hyla,	17	62	12	1	0	(2 from without)
Hylella,		2				
Acris,			1			
Chorophilus,			5			
Thoropa,		1				
	18	93	18	1	0	(2)

Total, 131.

This family was first defined by the author in the Natural History Review, 1865. The most nearly correct limitation previously existing was that of Günther, who, however, placed the species with parotoids in other families.

HEMIPHRACTIDÆ.

Diapophyses of the sacral vertebra cylindrical; mandible supporting a series of teeth. Cranium fully osseous. Terminal phalanges?

Of this family almost nothing is known, as it is as yet represented by but two rare species of the forests of the Neotropical region. It is probably intermediate between the Hylidæ and Cystignathidæ; in superficial appearance it approaches nearest the genus Triprion m., where the cephalic ossification and developement of additional teeth are carried far, and the digital dilatations are in like manner not largely developed.

HEMIPHRACTUS.

Wagler, Isis v. Oken, 1828, 735, 743, t. x. Peters, Monatsb. Preuss. Acad. 1862, 145.

In both species the vomerine teeth are in longitudinal series between the nares, curved outwards, and there appears to be teeth on the palatine arch. They have an acute prominence on the end of the muzzle, and the terminal tooth of the mandibular series is several times as large as the others, and prominent.

CYSTIGNATHIDÆ.

Vertebræ procœlian; no ribs; sacral diapophyses cylindrical, obtrihedral or slightly depressed distally, inclined upwards. Coccyx separate, attached to two condyles, without diapophyses. Terminal phalanges continuous, either uniformly conic, or with divergent terminal processes or their rudiments. Manubrium wanting or cartilaginous;* xiphisternum distinct. Auditory apparatus developed.† No teeth on the mandible.

This, after the Hylidæ the most extensive family of the Arcifera, embraces 101 species, which represent thirty-four generic types; four additional species represent four other supposed genera.

The most completely developed genus exhibits a cranium without fontanelle and with complete ethmoid arch, and a styloid osseous xiphisternum, with terminal cartilaginous disc; the auditory organs perfectly developed: the lowest, undeveloped ethmoid arch and frontoparietal roof, and disciform cartilaginous xiphisternum without style, with Eustachian tubes and membranum tympani wanting. Consistently

* Except in Limnocharis. † Except in Alsodes, according to one author.

with this succession, we have four modifications of this structure to adapt to as many modes of life: the aquatic, the terrestrial, the arboreal, and the subterranean. As the earth's surface is the common medium between the above extremes, so the species of terrestrial habits furnish us with none of the adaptive extremes of structure, but remain an intermediate group, from which the succession of structures, interrupted, it is true, passes towards the divergent types. Developemental structures accompany and confirm the adaptive, but by no means coincide; moreover, the adaptive is the evanescent character, while the developmental is the definitive.

The aquatic habit is attained when the digits behind are not only webbed, but when the external metatarsi are separated by membrane also. The arboreal, when the terminal phalanges are furnished with a terminal transverse limb, which supports an adhesive disc. The subterranean is shortened, and furnished with a great development of the first cuneiform bone of the tarsus, which is covered by a corneous sheath, and serves as a spade. The first may be combined with the third, as in Mixophyes and Chiroleptes, or it may be furnished with a bony over-roofing of the temporal muscles, and penetration of its integuments by the ossification of the cranium.

The fossorial spur is weak in Helioporus, weaker in Platyplectrum, and just represented in Ceratophrys and Gomphobates. The palmate foot is diminished in Calyptocephalus, reduced in Mixophyes and Chiroleptes, and represented by a trace in Hylorhina and Limnomedusa. The undeveloped ear is seen on one side only in a species of Crinia, and in Alsodes.

With regard to the dermal attachments, the following important varieties occur; in the family generally, but especially among Hylodes and Cystignathi, the dorsolateral septum is placed especially high up:—

Pseudes.—Septa in Pseudis as in Rana; in Lysapus the lateroventral line is a little widened. In Mixophyes f a s c i o l a t u s the lateroventrals are very wide, and leave the ventral free space very narrow behind the middle.

Ceratophrydes.—In (Gomphobates and) Tomopterna the lateral septa are narrow, and there are two posterior abdominal transverse septa, similar to those attached to the sternum. In Ceratophrys o r n a t u s these are wanting, but the dorsolateral line is very broad.

Criniæ.—Among these animals I have examined species of Helioporus, Platyplec-

trum,* Crinia, Borborocætes, Eusophus and Hyperolia, and in none can I find more than lateral traces of the epicoracoid and coracoid septa, except in the Hyperolia marmorata, where they are complete. The posterior abdominal is well developed in Eusophus nebulosus.

Pleurodemæ.—Ventrolateral low down, and posterior abdominal well developed in Pleurodema bibronii.

Hylodes.—Dorsolateral and ventrolateral far apart: the transverse posterior abdominal septum in the species of Lithodytes, in Ephirexis longipes, in Enhydrobius vomerinus (*Elosia* Girard) and Phyllobates rideus. I have not found it in Lithodytes (Craugastor) conspicillatus Gthr., Enhydrobius parvus† (*Hylodes* Gird.) and Limnocharis fuscus Bell (*Elosia nasus* Girard).

Cystignathi.—In all the species the structure is similar to that of Rana, except in the approximation of the dorsolateral lines, and the presence of the postabdominal septum, which is continuous with the lateroventrals, and is indicated externally in several of the species by a fold in its line of attachment.

The accompanying table exhibits the affinities of the genera, and the groups into which they naturally fall:

* P. occidentale, sp. nov.

Skin smooth; crural gland small; above medially dark, laterally pale ash, below dirty white; pupil erect; orbit less than length of muzzle.

Habit stout; distal end of tarsus not quite extending to end of muzzle; breadth of head behind scarcely less than one-half length of head and body, and one-eighth more than from posterior border of tympanum to opposite end of muzzle. Muzzle depressed in profile, retreating from prominent labial border, nostril nearer orbit than margin, the former distance equal narrowest interorbital breadth. Eyes not prominent; eyelids narrow. Vomerine series extending to exterior of choanæ, which, with the ostia tubæ Eustachii, are of usual size. Tongue extensively free. Tympanum concealed by skin. First, second and fourth fingers *equal*, the two inner with very large penultimate subarticular tubercles. Brachium attached under angle of mouth; middle of antebrachium extended measures end of muzzle. Tarsus broad, short, scarcely equal antebrachium; metatarsus moderate, with none but the cuneiform tubercle, which is incurved and pale edged. Toes short, except the fourth, with a trace of web, and margined.

Total length 1 in. 9·4 l.; muzzle to angle of jaws 8·5 l.; tibia 9 l.; foot 1 in. 2·1 l.

Habitat.—West Australia, *Daniel.*

† Perhaps owing to small size of specimen.

Frontoparietal bones developed.
An osseous xiphisternal style.

- Cystignathi, 21 sp.
  - Gnathophysa
  - Cystignathus
  - Tarsopterus
  - Gomphobates
- Xiphisternum a cartilaginous disc.
  - Pseudes, 7 sp.
    - Hylodes, 27 sp.
      - Pseudis
      - Lysapsus
      - Mixophyes
      - Pithecopsis
    - Hylodes
    - Lithodytes
    - Enhydrobius
    - Epirhexis
    - Phyllobates
    - Limnocharis
  - Ceratophrydes, 9 sp.
    - Zachænus
    - Stombus
    - Ceratophrys
    - Tomopterna
    - Chiroleptes
    - Limnomedusa

Frontoparietal bones undeveloped, embracing a fontanelle.
Xiphisternum with an osseous style.

- Pleurodemæ, 9 sp.
  - Pleurodema
  - Liuperus
  - Hylorhina
- Xiphisternum a cartilaginous plate.
  - Neobatrachus
  - Helioporus
  - Platyplectrum
  - Borborocætes
  - Crinia
  - Hyperolia
  - Cyclorhamphus
  - Alsodes
- Criniæ, 28 sp.
- Frontoparietals and ethmoid arch undeveloped.
  - Eusophus

The geographical distribution of these forms is as follows:

	Regio Australis.	Regio Neotropica.			
		Chili and S. of La Plata.	Central.	Mexican.	West Indian.
Cystignathi, . .	0	2	18	1	3
Hylodes, . . .	0	0	16	3	8
Ceratophrydes, . .	1	1	7	0	0
Pseudes, . . .	1	0	6	0	0
Pleurodemæ, . .	0	3	6	0	0
Criniæ, . . .	23	7	0	0	0

There are then known twenty-five Australian species, of which all but two possess an incomplete cranium, and none a bony xiphisternal style. In the Patagonian subregion thirteen species, of which ten exhibit an incomplete cranium, and five a complete bony xiphisternal style. In the Brazilian subregion fifty-three species, of which only six have an incomplete brain case, and twenty-four the osseous xiphisternal style. Mexico, three species with complete cranium, and one of these with style; the West Indies with eleven, none having the fontanelle, and three the style.

	R. Australis,	S. R. Patachonica,	S. R. Brasil.,	S. R. Mexic.,	S. R. Ind. Occ.
Total, ...	25.	13.	53.	4.	11.
Prefrontals fully developed,	0	3	22 (appr.)	3	10
Ear imperfect, . . .	1	4	0	0	0
No vomerine teeth, . .	9	1	13	0	1
Toes webbed, . . .	3	2	6	0	0
Fossorial shovel, . . .	7	1	1	0	0

In regard to the cranial development, the West Indian region is preëminent in this family as in the Hylidæ, the Brazilian inferior, and the Australian vastly below all; the degradation appearing in a certain degree regular. In the lack of vomerine teeth, (a feature of immaturity,) the Australian forms predominate. In possession of the Raniform xiphisternum the West Indian and Mexican subregions show fewer representatives than the Brazilian.

One species,—Lithodytes r i c o r d i i,—wanders from the R. Neotropica into the southern projection—Florida—of North America; no others are known to occur beyond the borders already stated. No species is common to the R. R. Australis and Neotropica, and but one genus,—Borborocætes. Two Brazilian species occur in the Southern West Indies, and two in Southern Mexico; probably three of the same country must be included in the Buenos Ayrean list.

The whole number of species must be reckoned at 108, which fall into 35 genera.

As yet we are acquainted with the fossil remains of but one species of Cystignathidæ,—a Ceratophrys, from a Brazilian cave. It has been regarded as identical with the C. d o r s a t a by Günther, Ann. Mag. Nat. Hist. 1859, pl. xv.

This family was first characterized by the author in Proc. Acad. Nat. Sci. 1863, 46; excluding, however, the genera Ceratophrys and Tomopterna; and subsequently more exactly in the Nat. Hist. Review 1865. Several changes, approximations to nature, are now proposed, and the genera for the first time defined. These were distributed in the last systematic arrangement (1858) in six *different families.*

Group I. PSEUDES.—Frontoparietal bones fully developed. Toes webbed, external metatarsi free; terminal phalanges acute. Xiphisternum a cartilaginous plate. Ear perfectly developed. Tongue broad, entire, adherent.

Cephalic derm distinct: vomerine teeth: no cuneiform shovel or lumbar gland. Prefrontals closely united; pupil horizontal, . PSEUDIS.

Cephalic derm distinct: vomerine teeth: no cuneiform shovel or lumbar gland: prefrontals widely separated from each other and frontoparietals, ... LYSAPSUS.

Cephalic derm distinct; vomerine teeth; a cuneiform shovel; no lumbar gland; prefrontals not closely united; pupil vertical, . MIXOPHYES.

Cephalic derm distinct; vomerine teeth; no cuneiform shovel; a lumbar gland; eyes anterior; prefrontals well united, transverse, ... PITHECOPSIS.

Cephalic derm involved in a rugose cranial ossification, temporal fossa overarched, completing postorbital arch; vomerine teeth; no cuneiform shovel or lumbar gland; eyes anterior; prefrontals extensively united and prolonged posteriorly, . . . CALYPTOCEPHALUS.

Group II. CERATOPHRYDES.—Frontoparietal bones fully developed. Toes free or slightly webbed; the external metatarsi bound; terminal phalanges simple. Xiphisternum a cartilaginous plate (so far known, emarginate). Ear perfectly developed. Tongue entire, little free.

a. A cuneiform shovel; cephalic derm distinct; no postorbital arch.

Eyelids not prolonged; prefrontals well separated; vomerine teeth; toes slightly webbed; inner finger opposable; form more elongate, CHIROLEPTES.

Prefrontals more or less united; eyelids not prolonged; vomerine teeth; toes slightly webbed; cranium elevated; form toad-like; inner finger not opposable; abdominal derm areolate, . . TOMOPTERNA.

aa. A cuneiform shovel; cephalic derm involved in cranial ossification. A postorbital bony arch.

Prefrontals wholly or in part separated; eyelids with a dermal prolongation; vomerine teeth; toes more or less palmate; cranium elevated; form toad-like; inner finger not opposable; pupil transverse, ... CERATOPHRYS.

aaa. No cuneiform shovel or postorbital arch; cephalic derm not involved in ossification.

Prefrontals widely separated; eyelids with dermal prolongation; vomerine teeth; toes nearly free; cranium elevated, form toad-like; inner finger not opposable, ... STOMBUS.*

Prefrontals in close contact; eyelids not prolonged; vomerine teeth on palatine arch; toes free; cranium broad; eyes subanterior, pupil horizontal; form squat, abdomen smooth, . . . ZACHÆNUS.†

Prefrontals not united, removed from the frontals; vomerine teeth; toes nearly free; pupil vertical, ... LIMNOMEDUSA.‡

? ? ?

Prefrontals? eyelids simple; no vomerine teeth; toes free; eyes lateral, pupil horizontal; form frog-like, ... NATTERERIA.

Group III. CRINIÆ.—Frontoparietal bones embracing a large fontanelle; cephalic derm free. Auditory apparatus developed, minute, or wanting. External metatarsi bound, digits free, or rarely, webbed; terminal phalanges simple. Prefrontals never closely united, rarely in contact. Xiphisternum not distinguishable into style and disc, broad, emarginate, cartilaginous. Tongue largely free.

a. Ethmoid bone with superior arch complete; a metatarsal shovel; toes margined or webbed. Vomerine teeth in straight transverse series; form stout.

Parotoid glands continued to groin and on dorsum; feet nearly free; pupil round, ... HELIOPORUS.

No parotoid glands; feet fully webbed, ... NEOBATRACHUS.

No parotoid glands; feet webless, ... PLATYPLECTRUM.

? *aa.* Ethmoid arch complete; no metatarsal shovel; toes webbed; form depressed.

Auditory apparatus minute; vomerine teeth; xiphisternum with a proximal semiossified portion, ... CYCLORHAMPHUS.

aaa. Ethmoid arch complete, or nearly so; digits free; no cuneiform shovel.

Large parotoid glands; no vomerine teeth, ... HYPEROLIA.

No parotoid glands; vomerine teeth in transverse series; xiphisternum broad, (with some basal bony deposit,) . . . . BORBOROCÆTES.§

* Type Ceratophrys boiei Wied.

† Type Cystignathus parvulus Girard.

‡ Type Cystignathus macroglossus Dum. and Bibr.

§ Includes *Limnodynastes* Fitz. Günther.

No parotoid glands; vomerine teeth wanting or in minute fasciculi; xiphisternum slender, without bony deposit. Abdominal integumen usually areolate, ... CRINIA.*

aaaa. Ethmoid arch completed by cartilage above; digits free; no shovel.

No parotoids; vomerine teeth; pupil round; auditory organs rudimental, ... EUSOPHUS.

aaaaa. Ethmoid arch? No metatarsal shovel. "Auditory organs wanting." Toes slightly webbed.

Vomerine teeth; no parotoids, ... ALSODES.

Group IV. PLEURODEMÆ.—Frontoparietal bones embracing a fontanelle; auditory apparatus developed; digits free, or slightly webbed; external metatarsals bound, terminal phalanges simple; xiphisternum an osseous style, with one or more distinct terminal cartilage discs. Tongue entire. Cephalic derm free.

a. Inguinal glands; pupil horizontal; xiphisternal cartilage emarginate or bifurcate.

Vomerine teeth; prefrontals well separated; terminal phalanges short, PLEURODEMA.

aa. No inguinal glands; pupil horizontal.

No vomerine teeth; prefrontals entirely separated; terminal phalanges short, ... LIUPERUS.

aaa. No inguinal glands; xiphisternal cartilage entire; pupil erect.

Vomerine teeth; prefrontals widely separated by the osseous ethmoid; terminal phalanges elongate; limbs elongate, ... HYLORHINA.

Group V. HYLODES.—Frontoparietal bones and auditory apparatus fully developed; digits free, or nearly so; external metatarsi bound; terminal phalanges with a transverse limb, which supports dermal discs. Cranium elongate, plane. Xiphisternum without style, scutiform, emarginate or bilobed, osseous or cartilaginous.

* Crinia i g n i t a m. sp. nov.

Prefrontals well separated; sides, throat, thorax and abdomen areolate; back without folds, but with numerous oval and elongate warts; two metatarsal tubercles; black, with scattered red spots; groins and femora behind red, pink varied; limbs brown above, black banded; below white. A strong short tarsal fold; toes narrowly margined; base of fourth toe extends to nostril; heel to orbit; sacral region nearly flat; tympanum indistinct, one-third orbit; tubercles of palm numerous, strong, two exterior largest. A flat glandular aggregation at rictus oris; nostril as near lip as orbit. End of forearm to end of muzzle. Length of head and body about an inch.

This species has a considerably shorter head than the following.

Habitat.—West Australia, *Daniel.* Mus. Acad. Nat. Sci.

a. Prefrontals well separated, rarely the convexities of the inner borders in contact.

b. Manubrium cartilaginous.

Muzzle and canthus rostralis angulated, projecting; vomerine teeth; digital dilatations small, ... ENHYDROBIUS.*

Muzzle and canthus rostralis contracted, little marked; vomerine teeth; digital dilatations large, ... EPIRHEXIS.†

Muzzle and canthus rostralis prominent, angulated; no vomerine teeth, PHYLLOBATES.‡

bb. Manubrium osseous, styloid.

Muzzle and canthus rostralis angulated; no vomerine teeth, . . LIMNOCHARIS.

aa. Prefrontals united throughout by close suture, and usually in contact with frontoparietals.

Abdomen smooth; xiphisternum broad, ... LITHODYTES.

Abdomen areolate; xiphisternum slender, entirely cartilaginous, . HYLODES.

Group VI. CYSTIGNATHI.—Frontoparietals and auditory apparatus fully developed. Cephalic derm free. External metatarsi bound, digits free, terminal phalanges simple. Xiphisternum a distinctly defined slender osseous style, with distal undivided cartilaginous disc.

a. Xiphisternal style emarginate, and with two distal cartilaginous discs.

Form toad-like; no parotoids or vomerine teeth; isolated inguinal glands; two acute metatarsal spurs; pupil horizontal, . . GOMPHOBATES.

? { Form more elongate; no parotoids or vomerine teeth; no inguinal glands; metatarsal tubercles small, ... TARSOPTERUS.

aa. Xiphisternal style and distal disc undivided.

No inguinal glands, ... CYSTIGNATHUS.

Glandular aggregations on the loins, ... GNATHOPHYSA.

Genera incertæ sedis.

1. Probably in Group Ceratophrydes.

Superior cranial plane much contracted, with elevated ridges behind. Eyelids not prolonged; no cuneiform shovel or parotoid glands; small dilatations on toes of posterior extremity; no palmations; belly areolate, ... STRABOMANTIS.

2. Among Cystignathi, or a new group.

Superior cranial plane contracted, probably no fontanelle; auditory apparatus undeveloped; digits webbed, outer metatarsi bound, no dilatations; no vomerine teeth; pupil round, ... TELMATOBIUS.

* Includes *Elosia* Tschudi.

† Type *Batrachyla longipes* Baird.

‡ Includes *Crossodactylus* Dum., Bibr.

3. Hylodes, probably.

Cranium broad, rounded; digital dilatations supported by a strong cross-limb; no parotoids; xiphisternum with a distal, entire cartilage; vomerine teeth; muzzle and canthus, not marked, . . BATRACHYLA.

4. Hylodes or Cystignathi?

Head normal; vomerine teeth; parotoid gland; digits not webbed; thumb of male spurred; minute posterior digital dilatations, . PLECTROMANTIS.

5. To ? Cystignathi or Ceratophrydes.

A cavum tympani. Xiphisternum? Sacrum? Cuneiform bone little developed; form elongate; toes free; parotoid glands; no vomerine teeth; tongue extensively free; cranium probably complete above pupil? . . . . . NATTERERIA.

Supplement on the osseous structures of the Types of the Urodela.

It is as yet not always possible to distinguish differing plans of structure from differing degrees of development of a single plan. The assumption of the faculty of reproduction and cessation of developement at any of the various stages through which most vertebrates pass, would give rise to a variety of genera and species. That the comparative characters of existing genera, etc., do in very many cases illustrate in part such a hypothesis, is well known; and the fact, which has been laid down* as a rule of zoology, that "*every character distinguishing suborders, families, and genera, will be found among the individuals of some species, living or extinct, to mark mere varieties or stages of growth,*" is also in its favor; but it is opposed by the frequent existence of superadded structures, which are of the nature of adaptations to external circumstances. Both the more comprehensive "plans" or "groups" and the subordinate "genera," differ from each other in ways which have the above two kinds of significance separate or together.

With reference to these propositions, and the ultimate problem of the origin of species, no group presents greater facilities for investigation than the Urodele Batrachia. A few points are collated in the following pages, with this in view.

The Batrachia Urodela have been regarded as naturally distinguished into those with persistent, and those with temporary branchiæ,—perennibranchiata and caducibranchiata,—by almost all naturalists. The feature has been regarded either as of primary importance, as by Wagler and Buonaparte, or as secondary, as by Cuvier, Duméril, and Müller. The types known as Perennibranchiates are Siren, Proteus, Necturus and Siredon. The skeletal features presented by these are so diverse

* Proc. Acad. Philada. 1862, 75: on p. 66 (middle) "generic" should be read *genetic*.

as to indicate at once their pertinence to widely different groups; and in the case of Siredon, an identity with a known series of the Caducibranchiates, the Amblystomata. This identity is rendered plain in the appended diagnosis.

In certain species of the genera Spelerpes and Amblystoma,* the branchiæ remain to near the adult age, and are the last larval features to disappear. I have frequently seen the apparently adult Amblystoma m a v o r t i u m with considerable stumps of the branchiæ remaining, and even a few fimbriæ. The abundance and size of the larvæ of Spelerpes s a l m o n e u s, and rarity of the adults, have been pointed out by Prof. Baird,† who also has recorded his belief in the great probability of the Siredon p i s c i f o r m i s being the larva of some unknown Amblystoma. The latter creatures are known to lay eggs, and hence the probability of their being adults, and not larvæ. In another species with completely developed gills and dorsal and caudal fin, brought by Dr. Coues from Arizona, I find largely developed ovaries filled with eggs, some in an advanced stage. Moreover, the carpal and tarsal bones are ossified, although cartilaginous in many Urodela, which lose the branchiæ.

The question appears, however, to be finally settled by the remarkable facts observed recently at the Jardin des Plantes by Prof. A. Duméril. Siredons laid eggs, which hatched; the larvæ developed into Siredons, and, continuing to change, became Amblystomas! a confirmation of the suspicion of Prof. Baird. The character is in this case *not even specific.*

The position and tissue of the external branchiæ render them liable to injury; the following illustrates how little such injury affects the vitality of the individual: Dr. Coues states that his Siredons were taken in a well, by a baited hook. They were laid in the scorching sun, and remained there nearly an hour before being carried away and placed in water. They recovered perfectly; the skin exuded moisture during their exposure to the heat. The gills were *black* in this species, in life.

Some years ago I had occasion to observe a Siren confined in an aquarium, which had been taken near Alton, Ill. (Lat. 39°). I first saw it in midwinter; it was then without gills, but frequently came to the surface and took mouthfuls of air, parts of which would escape through the slits on the neck. There were frequently convulsive movements of the latter region, by which the anterior and sometimes the posterior slits were opened. Water was at the same time drawn in through the *external nares*, and probably reached the pharyngeal cavity. The animal was said to have suffered an absorption of the gills, which lasted two weeks, during which time it would take no

* In Amblystoma p u n c t a t u m and o p a c u m the branchiæ disappear while the animal is but half its future size: the period at which they disappear in Desmognathus f u s c a appears to vary, but averages as the preceding; in Hemidactylium s c u t a t u m and Geotriton c a r b o n a r i u s their absorption takes place while the animal is very small. In Plethodon e r y t h r o n o t u s they also remain a very short time and are of no functional value, as the larva does not enter the water after leaving the egg.

† Jour. Acad. Nat. Sci. Philada., i. p. 281.

food; but I suspected they had been nibbled off by some Pomotes (Sunfish) confined in the same aquarium, who, attracted by their rosy color, thought them lawful prey. There were very small stumps remaining, of which the two anterior, seventeen days after my first observation, developed a minute brown fringe on the under side. Twenty-four days later, the stumps were longer, and the two anterior now bore a double series of processes, which were of a rosy slate color. The animal still came to the surface for air, and disliked excessively to be removed from the water. It measured 9 in. 9 lin. in length, and was at first pale brown, with numerous black dots above, and pale slate below,—but became darker and the spots larger. There was a golden band on the side of the lip and "cheek," and the toes were tipped with a corneous cap. Further observations went no further than to show that this Siren could live for more than two months deprived of its branchiæ, and that the latter can be reproduced.

I have seen a specimen of the Siren striata in which the branchial fimbriæ were thickened, and the three main rami adherent throughout their length to the pharyngeal walls between the fissures; being thus entirely abortive and in part atrophied. In skeletal and other features, this species does not differ from the Siren lacertina.

Another feature characteristic of the immature stages of both tailed and tailless Batrachia, is permanent in the "perennibranchiate" types just mentioned, and in the Amphiuma and Protonopsis,—*i. e.*, the cartilaginous condition of the intervertebral tissue, and consequent retention of the biconcave or fish-like vertebra. It does not appear to have been previously pointed out that this feature persists in all the species of the American types Amblystomidæ and Plethodontidæ, contrary to the condition in the forms of the Old World.

Prof. Baird, in the first synopsis of our genera published, pointed out the difference between Amblystoma and our other genera, in the ossification of the tarsus and carpus of the former, and cartilaginous state of the latter. This is again a strictly developmental difference, identical with the Perennibranchiates and extinct Xenorhachia.

With respect to the cranial and tarsal ossifications, the Siredon is first identical with the larva of Amblystoma,—*e. g.*, punctatum,—when half the dimensions of the adult; bearing distinct nasal and prefrontal bones with maxillaries, and the longitudinal palatines with a slight ligamentous connection with the reduced pterygoids, forming an arch separate from the parasphenoid. In *some* Siredons the carpal and tarsal bones are fully ossified,—a condition which I have not yet observed in any Amblystoma larva.

The structural features of Necturus are very different, as has been in part pointed out by authors, and *are identical with those of the larva of Spelerpes rubra and salmonea*. Both types lack the maxillaries, nasals and prefrontals, and exhibit a broad

continuous palato-pterygoid arch, in close contact with the parasphenoid. The two ceratohyals are confluent, the posterior is present, and there are but three superior hyoid arches. These structures coëxist in the larva of Spelerpes salmonea, at a period when it has attained double the size of that of Amblystoma punctatum, and equal to that of its adult. The hyoid elements only I have not yet seen as fully ossified in Spelerpes larva, as in the Necturus. The relation then between Necturus and Spelerpes is probably the same as that between Siredon and Amblystoma, and the same (as I have pointed out, Proc. Acad. Phil. 1862, p. 66) as that between Protonopsis and Megalobatrachus, in respect to the pharyngeal fissures and hyoid pleurapophyses.

Dr. Gray, after Prof. Baird, has very judiciously excluded the Siredons from the Perennibranchiates proper, though Müller retained them as the type of his family *Acholotida*. They undoubtedly belong to the group Caducibranchiata, and family Amblystomidæ. *A priori*, therefore, Necturus might be placed among the Plethodontidæ of the same great series, but its structure, so far as observations have been made, is permanent. It also represents a far less advanced larval bony structure than Siredon, but so do the adult Plethodontidæ in most respects than the Amblystomas. The incomplete coincidence of advance in different organs may be thus illustrated:

Amblystomidæ.	Plethodontidæ.
Superior.	Inferior.
Carpus and tarsus osseous.	Carpus and tarsus cartilaginous.
Premaxillary fontanelle closed.	Premaxillary fontanelle open.
Inferior.	Superior.
O. pterygoideum persistent.	O. pterygoideum obliterated.

The inferiority of some Plethodontidæ is seen in the non-distinction of the digits (Geotriton), the thinness of the ossification of the parietal membrane bones (Batrachoseps), and in Spelerpes lineolus m, from Vera Cruz, the persistence of the membranous cranium by the limitation of the parietal bones to two small oval lateral scales, and the wide divarication of the posterior extremities of the frontals.

We may then conclude that developmental features are thoroughly constant in most types, but in some one or more cases in many, some are known and the others will probably be found, to illustrate the law of variation above laid down. We are then brought face to face with phenomena of modification of species, which do not come to view in the irregular aspect of a theory of "descent with modification" by a fortuitous "natural selection," which could affect only a certain class of structures. We want a theory which will explain the times and causes of the stability of types consisting of co-existent structures, and the instability of such co-existences; just as the compounds of the elements have their conditions of stability and instability; the elements, of stable or unstable union. We want to ascertain that law of harmony by which the coincidences of structures have been varied by their reproduction being shifted from stage to stage of individual development, till the present faunæ are the result.

This view has not been overlooked by Darwin, who, however, treats of it very briefly, and appears to attach it to the theory of adaptations, or modification for a physiological purpose. He says, Origin of Species, 388, (American Edition, 1860): "We may extend this view to whole families or even classes. The fore limbs, which served as legs in the parent species, may become, by a long course of modification, adapted in one descendant to act as hands, in another as paddles, in another as wings; and on the above two principles,—namely, of each successive modification supervening at a rather later age, and being inherited at a correspondingly late age, —the fore limbs in the embryos of the several descendants of the parent species will still resemble each other closely, for they will not have been modified. But in each individual new species, the embryonic fore limbs will differ greatly from the fore limbs in the mature animal; the limbs in the latter having undergone much modification at a rather late period of life, and having thus been converted into hands, paddles or wings." He then inclines to assign this change to the necessity of external circumstance. But such modification must be the same in kind as others, which the same hypothesis must explain; and of which the same author remarks (p. 382): "We cannot, for instance, suppose that in the embryos of the Vertebrata the peculiar loop-like course of the arteries near the branchial slits are related to similar conditions in the young mammal, which is nourished in the womb of its mother, in the egg of the bird which is hatched in a nest, and in the spawn of a frog under water. We have no more reason to believe in such a relation than we have to believe that the same bones in the hand of a man, wing of a bat, and fin of a porpoise, are related to similar conditions of life. No one will suppose that the stripes on the whelp of the lion or the spots on the young blackbird are of any use to these animals, or related to the conditions to which they are exposed."

Among the higher groups of animals can be detected series "homologous" on the same principle as the alcohols (?compound radicals) and their derivatives; and the component types of each can be, and have been in many instances, shown to be "heterologous," as are the ethers,—mercaptans, aldehydes, acids, etc. Among the Mammalia two (homologous series) have been pointed out: Implacentialia and Placentialia;* possibly such are the types Altrices and Præcoces among Aves. Of a lesser grade in this class are the parallel series of Pullastræ and Gallinæ, of Clamatores and Oscines. Among Tortoises I have alluded to the Pleurodira† as compared with the remainder of the order, already parallelized by Wagler; and of lesser grade, the series among Lacertilia of Acrodonta and Iguania, parallelized by Dumèril and Bibron, and of Teidæ and Lacertidæ, compared by Wiegmann: I have discovered a

* Perhaps more exist, as Flower and Huxley cast doubts upon some of the supposed distinctions of these two. Professor Dana's Megasthenes and Microsthenes may also be such, but they lack as yet the necessary anatomical demonstration.

† Proc. Acad. Philada., 1864.

full parallelism between the Raniform and Arciferous Anura.* It is carried out between the Characini and a group of remaining Physostomous fishes perhaps not yet well defined:† it is exhibited between the orders Diptera and Hymenoptera among insects. None of these comparisons can be allowed, of course, without the most searching anatomical, histological, and embryological analysis.

This *heterology* is what Swainson and others called "analogy," as distinguished from affinity. It *generally* relates genera of different zoological regions. Mimetic analogy, on the contrary, relates genera of the same region; it is a superficial imitation which has occurred to critical biologists, and is of much interest, though as yet but little investigated. It has as yet been observed in external characters only, but occurs in internal also; it has been accounted for in the first case by the supposed immunity from enemies, arising from resemblance to well defended types. No such explanation will, however, answer in the latter case. I believe such coincidences express merely the developmental type common to many heterologous series of a given Zoological "Region." This will be alluded to a few pages later.

To return from this digression.

Three principal types of Urodela may be discovered in their skeletal arrangements; viz.:

TRACHYSTOMATA (Mueller).

O. maxillaria wanting: nasalia embraced by spine of premaxillaria: prefrontalia wanting; palatina wanting; pterygoidea wanting; orbitosphenoids large, anterior, forming part of palate; mandible with condyle, without teeth on the dentale. Ceratohyals, first two distinct.

With branchiæ, biconcave vertebræ, and cartilaginous carpus, as characters of less intrinsic value.—

Fam. Sirenidae. Genus Siren.

PROTEIDA (Mueller).

O. maxillare and prefrontalia wanting; palatinum and pterygoideum present, continuous; nasalia wanting; orbitosphenoid elongate, not forming part of palate; mandible with teeth on the dentale. Ceratohyals, first two connate.

Subordinate features: branchiæ, biconcave vertebræ, and cartilaginous carpus and tarsus.—

Fam. Proteidae; Proteus and Necturus.

CADUCIBRANCHIATA.‡

O. maxillare present; prefrontale present, (with one exception); premaxillaria embraced by nasalia; palatina present, not approximated to usually present pterygoidea; orbitosphenoid large, not reaching palatal surface; mandible with teeth on the dentale.

* Proc. Acad. Nat. Sci., 1864, 181.

† Gill's Eventognathi and Nematognathi being of course omitted.

‡ This name, though not strictly applicable to Siredons included in the suborder, may be retained.

Branchiæ or fissures present or absent; vertebræ amphi- or opisthocœlian; tarsus and carpus cartilaginous or osseous.—

Families Amphiumidae, Protonopsidae, Desmognathidae, Plethodontidae, Amblystomidae, Hynobiidae, Salamandridae, Pleurodelidae.

PROTEIDA.

This suborder was established by J. Müller, and is the same as the Proteidæ of Gray.

But one species of Proteus is generally recognized, though Fryer* in 1846 pointed out the probable existence of a second, and Fitzinger in 1850† described and named seven. The latter author had over four hundred specimens at his disposal, and gives good diagnoses from external characters, including color. The latter feature is liable to change of shade according to Michahelles,‡ who states that of twenty specimens kept by him, only six retained their original flesh color after a lapse of some months, the remainder becoming bluish black. Dr. Fitzinger promised to make public the results of an anatomical study of his species, but has not yet, to my knowledge, accomplished it. In the meantime I drew up the following characters of five undoubted species from seven skeletons, types of the above, preserved in the private museum of Prof. Hyrtl, in Vienna.

A. Two condyles on the o. o. supraoccipitale.

Longitudinal and transverse occipital crests none. Vertebræ 23. Premaxillary teeth, seven each side; mandibulars seventeen, no teeth on the o. operculare. From coronoid process to angle of ramus, nearly as long as from coronoid to symphysis. Muzzle narrowed, canthus rostralis weak, ... zoisii.

AA. No condyles on the supraoccipitale.

I. Twenty-three dorsal vertebræ; an occipital crest.

Premaxillary teeth eight, mandibulars twenty-one, a few operculars. Coronoid process scarcely developed. Muzzle, and hence the o. o. frontalia exceedingly slender; latter, with the parietals convex, (? from drying ?) . . . carrarae.

II. Twenty-five to six dorsal vertebræ; a longitudinal occipital crest.

a. No teeth on o. operculare; premaxillaries 8—9.

21—2 mandibulars; from coronoid process to angle much shorter than from former to symphysis; no groove below coronoid process. Muzzle longer than following; o. o. frontalia concave medially, parietalia plane; canthus rostralis strong,

xanthostictus.

* Archiv. für Naturgeschichte, 189.

† Sitzungsberichte Wiener Academie, 291.

‡ Isis von Oken, 1831, 505.

aa. Teeth on operculare; premaxillaries 8.

Mandibulars 21; from coronoid to angle much shorter than from former to symphysis; groove below coronoid extending anteriorly; muzzle shorter; frontals plane, parietals and occipitals concave; canthus strong, ... schreibersii.

aaa. Teeth on operculare, premaxillary teeth ten (9).

Twenty-nine (four) mandibulars; coronoid without groove below, much nearer angle mandible than symphysis; muzzle long, frontals narrow plane; canthus not strong, ... anguinus.

I have retained the name of the original species for the last of these species, which Fitzinger has called *P. laurentii.* Zoisii is the stoutest in proportion to the length. P. carrarae is from Dalmatia, while the others are from Carinthia. A specimen like P. xanthostictus, but with nine premaxillary teeth, has been named *freyeri*, and one very near anguinus, with twenty-four mandibulars, has been named *heidingerii.*

CADUCIBRANCHIATA.

It is customary to regard this group as presenting two types, one with, and the other without pharyngeal fissures. But this feature is of no greater value than any other, as the very nearly allied genera Protonopsis and Megalobatrachus differ in this respect.

A. An axial cranial bone (? vomer) in front of orbitosphenoids, and one forming palatal surface in front of parasphenoid. Teeth on the outer anterior margin of palatines. Urohyal and basihyals distinct; two anterior ceratohyals connate.

I. Prefrontals and pterygoids present.

Parietals prolonged laterally, not reaching prefrontals. Orbitosphenoid separated by membrane from proötic. Vestibule wall osseous internally. Premaxillaries consolidated.

Carpus and tarsus cartilaginous.

Vertebræ biconcave.

Neck with a pharyngeal slit.

Occipital condyles on cylindrical pedestal.

Mandible elevated in part by tendon passing over parietal bone, and arising from atlas.

Amphiumidæ—Two genera, Amphiuma, Muræ̀nopsis.

The occipital condyles and temporo-cervical tendon are quite as in Desmognathus; they have not been previously described. In Amphiuma means there is a minute, not articulated bone on the suture between the o. o. frontalia and præfrontalia, in the situation of a lachrymal.

There are some approximations to Cœcilia in Amphiumidæ. It does not appear to have been noticed that the latter possess minute scales; the free margin of the frontal seems to foreshadow the overroofing of the orbit and temporal fossa seen in Cœcilia. There is also a very large foramen or canal passing through the o. maxillare from near its middle to the orbit, foreshadowing the *canalis tentaculiferus* of Cœcilia: a narrow one occurs in the same situation in Protonopsis. Further, the prominent horizontal anterior inferior processes of the vertebral centra are the same in Amphiuma and Cœcilia.

B. No anterior axial cranial bone; teeth on anterior margin of o. o. palatina.

II. Prefrontals and pterygoids present.

Parietals and prefrontals prolonged, meeting and embracing frontals.

Orbitosphenoid separated from proötic by membranous wall.

Wall of vestibule membranous internally.

Premaxillaries separated.

Carpus and tarsus cartilaginous.

Vertebræ biconcave.

Occipital condyles sessile.

Protonopsidæ.—Genera Protonopsis, Megalobatrachus; Nearctic and Palæarctic.

C. No anterior axial bone; palatines not prolonged over parasphenoid bearing teeth on the posterior portion. No postorbital arch.

III. Prefrontals and pterygoids present.

Parietals and prefrontals prolonged, meeting, embracing frontals.

Orbitosphenoid separated from pro tic by membranous wall.

Wall of vestibule osseous.

Premaxillaries distinct, usually not embracing a fontanelle.

No dentigerous plates on the parasphenoid.

Carpus and tarsus osseous.

Vertebræ amphicœlian (biconcave.)

Occipital condyles sessile.

Amblystomidæ.—Genera, Amblystoma, Ensatina, and Onychodactylus. North America; one species in Japan.

IV. Prefrontals present, pterygoids wanting.

Prefrontals not prolonged or embracing frontals; parietals slightly embracing.

Orbitosphenoids separated by membrane from proötic.

Vestibule, inner wall osseous.

Premaxillaries always embracing a fontanelle.

Dentigerous plates on the parasphenoid.

Carpus and tarsus cartilaginous.

Vertebræ amphicœlian.

Occipital condyles sessile.

PLETHODONTIDÆ.—Genera Plethodon, Hemidactylium, Spelerpes, Geotriton, and Batrachoseps. North America; seven north neotropical species, one in Siam, one in South Europe.

This family, with that preceding and that following, have been regarded by Dr. Gray as subtypes of one family,—his Plethodontidæ. Dr. Hallowell elevated the Amblystomidæ to its present rank in 1859, and I have followed him, and can now add several confirmatory characters. Nevertheless, the frontals are not embraced by the parietals and prefrontals in Onychodactylus, but are as in Plethodon; I do not know the structure of its tarsi and carpi. In Ensatina also, the premaxillary embraces a fontanelle, as in the present family. Eschscholtz correctly represents Batrachoseps attenuatus as without prefrontals. An elongate process of the frontal occupies only part of its place, forming no suture with the maxillary; this is quite different from Desmognathus, where the orbit is completed by the union of frontal and maxillary. In Batrachoseps quadridigitatus the prefrontal occupies this depression as an elongate vertical scale.

In Spelerpes rubra the quadratum presents a small internal anterior ala, which has a superficial resemblance to a pterygoid. In this species there is apparently an azygus bone behind the premaxillaries; this is, however, only the exposed extremity of their united spines, which are nearly or quite isolated by the approximation of the anterior parts of the nasale. It does not occur in the S. salmonea.

All the characters of this family are those of low developement, and approximations to the larval condition, except the loss of the pterygoid; one of the species exhibits a subocular cirrhus, which occurs in some of the Gymnophidia (Cœcilia) and Dactylethra among Anura. It is probably the persistence of that long subocular tentacle characteristic of the early larval stage of Salamandridæ and Pleurodelidæ (*e. g.*, Salamandra Notophthalmus), and of a later larval stage of Dactylethra (vid. Wyman and Gray), where they resemble the appendages of the Siluridæ. They have been called crochets by Rusconi, and homologized with the cylindric cephalic processes of the larval Rana, with what correctness remains to be proven by observations on other types. In the young larva of Bufo americanus they are not developed, but the transverse black line, at whose extremities they appear in Rana, instead of vanishing, becomes a fissure, separating two longitudinal lateral lips from an equally prolonged transverse anterior lip, which has much the form of the labrum of an insect, as, *e. g.*, Locusta.

When the remains of the intervertebral cartilages are visible, they adhere to the posterior of two vertebræ, except in the single specimen of Hemidactylium scutatum, which I have examined, where they adhere to the anterior.

V. Prefrontals and pterygoids wanting.

Parietals not embracing frontals.

Orbitosphenoid separated by membrane from proötic.

Vestibule, internal wall osseous.

Premaxillaries embracing a fontanelle.

Dentigerous plates on the parasphenoid.

Carpus and tarsus cartilaginous.

Vertebræ opisthocœlian.

Occipital condyles on cylindrical pedestal.

Mandible elevated by tendon, which arises from atlas and moves over o. parietale.

DESMOGNATHIDÆ.—One genus, Desmognathus, North America.

This family is now first characterized.

The absence of o. prefrontale does not appear to be the result of its confluence at any late period, with the nasale; its ordinary position is traversed by the frontal suture. The frontal bone is decurved, and closes the preorbital aspect of the superpalatal vacuity, usually open.

D. No anterior axial bone. Palatines in contact, prolonged over parasphenoid, bearing teeth on posterior external margin.

VI. Prefrontals and pterygoids present, well developed.

Frontal not embraced by parietals and prefrontals.

Orbitosphenoid separated by membranous wall from proötic.

No dentigerous plates on the parasphenoid.

Carpus and tarsus?

Vertebræ?

Postfronto-squamosal arch or ligament none.

Occipital condyles sessile.

HYNOBIIDÆ.—Genus Hynobius, Japan.

E. No anterior axial bone. Palatines with posterior separate processes extending over the parasphenoid, bearing teeth on their inner margins.

VII. Prefrontals and pterygoids present.

Parietal entirely separated from prefrontals by broad frontals.

Orbitosphenoid confluent with proötic.

No dentigerous plates on the parasphenoid.

No postfronto-squamosal arch or ligament.

Carpus and tarsus osseous.

Vertebræ opisthocœlian.

Occipital condyles sessile.

SALAMANDRIDÆ.—Two genera: Salamandra, Triton, Regio Palæarctica.

This family was characterized by Dr. J. E. Gray, in Proc. Zoological Soc. London, 1858, 142.

VIII. Prefrontals and pterygoids present.

Parietals not embracing the broad frontals.

Orbitosphenoid

No dentigerous plates on the parasphenoid bone.

A postfronto-squamosal arch, sometimes ligamentous.

Carpus and tarsus osseous.

Vertebræ opisthocœlian.

Occipital condyles sessile.

PLEURODELIDÆ.—Genera Hemisalamandra, Neurergus, Lissotriton, Lophinus, Euproctus, Cynops, Notophthalmus, Pleurodeles, Glossolega, Siranota. Regio Palæarctica; three species in North America.

These genera form a series measured by the increasing strength and ossification of the post-frontoparietal arch, which has been pointed out by Gray and figured by Gervais, Duméril, and Dugès. It is first bony in Lophinus: in Glossolega it is very stout, and leaves but a small crotaphite foramen, while in Siranota it fills up the foramen, being entirely continuous with the parietal bone. On this ground Dr. Gray has regarded this genus as representing a family,—"Siranotidæ,"—but it does not appear to be more different from Glossolega than the latter is from Neurergus and Hemisalamandra.*

The study of the Mammalia, the Rapacious, Pullastrine, Gallinaceous and Passerine Birds, of the Sauria, Tortoises, Tailless Batrachians† and Malacopterygian Fishes, leads to the conclusion that these portions of the Fauna Neotropica represent much lower stages in their respective series than do the same types in the Regio Palæotropica. In a few types, as Zygodactyl Birds and Ophidia, there is, as far as our present knowledge extends, a seeming equivalency; but in no single group can a superiority be proven for the Fauna Neotropica; the tests of the grade being ever the retention of the characters of the incomplete stages of the extremes of the series, the relations of generalized and specialized structure, or, where we have not yet demonstrated thoroughly, by the affinities with forms whose relations in these respects *are* known. These relations coincide in *kind* with those contrasting the Faunæ of earlier and later geological periods, but not in *degree*, since they refer to the *subordinate* or

* The genera adopted are those arranged by me, Proc. Acad. 1862, 343. The preparations on which the preceding investigations have been made are the collections of Prof. Baird and myself; the former in the Museum of the Smithsonian Institution, Washington.

† This is in opposition to the following proposition of Günther, (Proc. Zool. Soc. Lond., 1858,) the contrary of which, I think, has been abundantly proven. He says: "Such a difference between the animal life of the New World and that of the Old as pertains to other parts of the animal kingdom, is not to be observed in the Batrachians. Dissimilarity and similarity of the Batrachia Fauna depend upon the zones."

homologous divisions of the classes and subclasses, and not to the classes themselves. Hence the relations between the two Faunæ will be those of differing minor epochs in geological time, through several of which some special forms may range; and we may safely conclude, from data above alluded to, that the Regio Palæotropica is one or more geologic *epochs* in advance of the R. Neotropica.

Between these Faunæ come the Nearctic and Palæarctic, of which Agassiz has said that the former was an epoch behind the latter. The undeveloped condition of our predominant types of Salamanders, our Pleurodont Saurians, our more numerous Clamatores and nine-quilled Oscines, and the comparative fewness of the ten-quilled Oscines, especially the highest, Turdidæ (including *Sylviidæ*), would indicate from an anatomical stand-point that this view is correct, though the balance of difference is small, and the northern regions are nearly identical.

As to the Regio Æthiopica, excepting of course Madagascar, in reptilian features it is almost equivalent to the R. Indica; in several points the southern extremity must be excepted from this comparison.

Of the R. Australis, Prof. Agassiz* has said that none of its animal products present that degree of peculiarity exhibited by the Mammalia. Its inferiority is plain, however, in the points below included; and if we consider any distributions from the centres to have taken place during brief epochs of time, this region will have had every opportunity of acquiring its few high types, as some Acrodont Lacertilia, and numerous birds,† which can be most readily transported; including a few high Oscines from its neighboring Palæotropical area.‡

On the whole, it cannot be said that the evidence for the succession here claimed is as yet much more than fragmentary; yet it appears to be sufficiently indicated, which cannot be said of any other order or succession.

The succession of the great regions and grounds therefore, may then be imperfectly illustrated as follows:

R. Australis.—Inferior in Monotrematous and Marsupial Mammalia, Pullastriform and Struthious Birds, Serpentiform Pleurodont Lacertilia, Arciferous Ba-

* Contrib. I. 44. Prof. A. also gives a table of Scincidæ from Duméril and Bibron, illustrating its distribution, from which it would appear that the greater number of limbless and digitless types are from other regions than the R. Australis. But of the twenty genera, with toes less than 4—4, but *eight* belong to the Scincidæ. Adding to these two from Gray's Catalogue, we have seven of them Australian, one South Æthiopian, one Palæarctic, and one Palæotropical. It possesses in addition the limbless families Pygopodidæ, Lialisidæ, and Aprasiidæ. It must at the same time be remembered that the most elevated Scincidæ belong to the *same* region Cyclodus, Hinulia, etc.

† Much must yet be allowed for the incompleteness of anatomical knowledge of the birds. The only system which, in many features, appears to nearly accord with nature, is that published by Wilh. Lilljeborg, Upsala Transactions, 1862.

‡ Vide articles by A. Wallace on distribution in the Malaysian and Australasian Archipelagos.

trachia, Pleurodire Tortoises, its Elapid venomous snakes, and the whole Flora, according to Unger.

R. Neotropica.—Marsupial and Edentate Mammalia, Inferior Rodentia and Quadrumana, Pleurodire Tortoises, Pleurodont Lacertilia, Arciferous Batrachia, Clamatorial and Pullastriform Birds, Characin and Erythrinid Malacopterigii.

R. Nearctica.—Lacking most of the inferior types of the preceding, it retains more Arcifera and Bufoniformia, Pleurodont Lacertilia, and Clamatores, than the following; possesses the inferior Urodela, the Aphredoderus and Percopsis, and wants as types of the

R. Palaearctica.—Higher Urodela, Acrodont Lacertilia, higher Gallinæ* and Oscines. This is inferior, however, to the last in Ophidia Solenoglypha.

R. Palaeotropica or Indica,—Superior in types of Teleostei, Batrachia Anura, Lacertilia Acrodonta, Testudinata,† Gallinaceous and Oscine Aves, Mammalia, including Homo.

If the above succession be marked out in present time, it has no doubt existed throughout a longer or more probably shorter series of recent geologic periods or epochs, and over areas of course only partially coinciding with those of the present Regions. This points to the Regio Palæotropica, faunally and florally most advanced in time, as the seat of first origin of the human species, as already indicated by revelation and tradition. The fact of its being the source of such a majority of the vegetable and animal products most useful to the species, is in harmony with this view; and more so is the known, almost regular departure from the typical symmetry of form and expression of mind by body, in the men of the different Regions. That these areas were occupied by man in this succession, determined by their preparation for maintaining a degree of developmental perfection, sufficient to enable him to take his part in "the struggle for existence," is a natural sequence of the relation in time.

Palæontology is as yet too incomplete to answer the question as to how ancient such a relation may be. Its indications are quite contradictory, and perhaps may not be relevant, prior to Cænozoic time.

Thus the resemblance between existing Australian and American types and tertiary European‡ forms successively, harmonizes with the existent relations between the faunæ here proposed; but the similarity between fresh water shells of the Upper Missouri Lignite and recent Indian forms, between American Eocene and European

* E. g., Phasianus, Tetrao, Lyrurus, Tetraogallus, etc.

† Possesses a greater number of distinct types of Emydidæ and Testudinidæ than the R. Nearctica, though not much beyond it.

‡ Among others, the extinct genera Polysemia *Myr.* and Heliarchon *Myr.* exhibit the unossified carpus and tarsus of the recent American Plethodontidæ.

Miocene plants, and between American Cretaceous and European Eocene plants, are of exactly contrary significance. Of the same meaning is the appearance of true Crocodiles* in American Cretaceous, equal European Eocene.

As progress is the rule in palæontology, the lapse of time will probably see a later equivalency of some kind between the characters of the products of the inferior Zoological Regions, *e. g.*, Australis, Neotropica, and of those characterizing the highest,—*e. g.*, Palæotropica, at the creation of man,—and *mostly* still remaining.

The ready and rapid naturalization of Palæotropical and Palæarctic plants in the North and South American and Australian regions, is a remarkable feature often noticed.† This will furnish the future palæontologist with the explanation of the modification of flora of a region on the introduction of a new epoch, and that by no course of descent within that region; and constituting a nearer equivalency, as above proposed, with that higher flora established long since in the Regio Palæotropica.

The extent of time during which the regions owe their products to migrations and modifications, may have been limited to periods or epochs only. In respect to terrestrial cold-blooded vertebrata, the following facts in their geographical distribution are patent; they have been observed also in other types:‡

First, the identity of many of the boreal genera throughout the earth; second, the

* With regard to the amphicœlian Crocodile genus Hyposaurus *Owen*, of the New Jersey Green Sand, I would state that it differs in one feature from all known extinct Crocodilians. The neural spines of the cervical vertebræ are acuminate, of considerable—finally, of great—height, the anterior standing transversely on the neural arch, the median subtetragonal, the posterior, as usual, longitudinal in section. In an anterior cervical vertebra, length 2 in., the spine is 2 in. 10 l. above the ceiling of the arch, and is acute; it receives a strong lateral wing from each posterior zygapophysis, which does not disappear till near the tip. These enclose a deep groove on each side behind, with a strictly perpendicular posterior median rounded rib; in front a narrow keel extends from the tip to the neural canal; the lateral alæ are curved backwards. On a more posterior cervical, the lateral alæ are very heavy, short and rounded, and enclose no groove with the slightly projecting posterior vertical rib, while the anterior keel has become a strong compressed wing, dividing two shallow anterior grooves; breadth and length equal in section. In a last cervical, length 2 in. 2 l., the longitudinal section (equal about an inch) is longitudinal cuneiform, owing to the projection of the anterior ala. In an anterior dorsal the section is longitudinal (1 in. 5 l.); the lateral ribs remain at the base only, and the posterior carina is strong and sharp; it is acuminate, and was probably subacute, but is broken at tip; if restored would measure 4 in. 6 l. at least.

This creature possessed some kind of elevated dorsal carina, probably dermal, as in some Anolidæ and Iguanidæ, though the spines are not acute and ribbed in the latter. Their appearance in Hyposaurus suggests some kind of conic dermal horny sheath as defensive weapons; the vertebral line could not in any case have been covered by flat bony plates, as in ordinary Crocodilia. (See Leidy's Cretaceous Reptiles of the United States, 1865, p. 18.)

† See Dr. J. D. Hooker's article (Linnæan Society) on Naturalization of European Plants in New Zealand, and Prof. A. Gray's Botany of the Northern United States.

‡ A. Murray on Coleoptera, Old Calabar. Trans. Linnæan Soc. Lond., 1863.

occurrence of closely affined forms in the most nearly approximated regions of West Africa and South America; third, the appearance of similar forms in the most adjacent parts of South America and Australia.

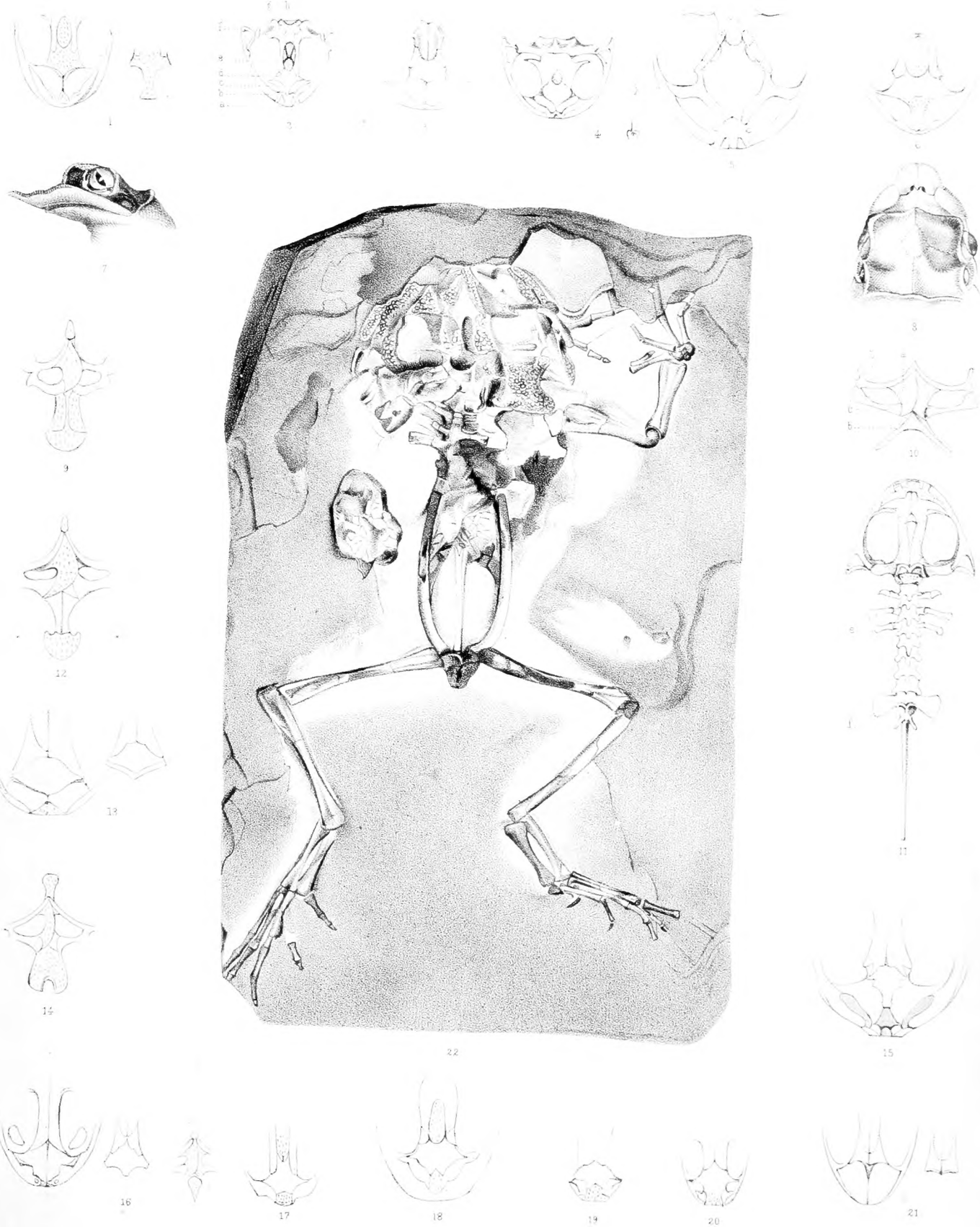
Finally, as Guyot* points out that the races of man are inferior as we reach the southern extremities of the continents which are prolonged into the great Water Hemisphere, so it can be shown that these extremities produce the greater number of "degraded" or "undeveloped" genera of Batrachia Anura, as indicated by the condition of their cranial bones, sternum, etc.

* Earth and Man.

EXPLANATION OF PLATE 25.

Fig. 1. Thoropa missiesii *Bibr.*, Rio Janeiro. Anterior part of cranium above.

2. Chorophilus oculatus *Daud.* (*Cystignathus ornatus* Gthr., not *C. oculatus* Holbr.) *a*, premaxillaries; *b*, maxillaries; *c*, prefrontals; *d*, ethmoid; *e*, frontoparietal; *f*, quadratum; *g*, proötic; *h*, exoccipital. From Georgia.
3. Scytopis venulosus *Daud.*, Brazil.
4. Smilisca baudinii *D. & B.*. Mexico: *g*, anterior and posterior terminal phalanges.
5. Hyla palmata, Brazil.
6. Agalychnis moreletii, Guatimala.
7—8. Triprion petasatus m., Yucatan.
9. Scaphiopus solitarius, Georgia.
10—11. Discoglossus pictus, Greece: *a*, arched cartilage; *b*, acromial; *c*, coracoid; *d*, xiphisternal; *e*, ribs; *f*, coccygeal diapophyses.
12. Pelobates fuscus, Austria.
13. Megalophrys montanus, Java.
14. Chiroleptes australis, New S.
15. Gnathophysa ocellata, Surinam.
16. Pithecopus fuliginosus, Brazil.
17. Borborocaetes peronii, Australia.
18. Hylorhina aenea, Chili.
19. Phyllobates bicolor, Cuba.
20. Enhydrobius vomerinus, Rio Janeiro.
21. Lithodytes oxyrhynchus, West Indies
22. Zaphrissa eurypelis m., sp. nov. Fossil.



BATRACHIA.

J. GOLD, DEL.

T. SINCLAIR'S LITH. PHILA.